VOLUME XXXVII NUMBER TWO

THE NATIONAL GEOGRAPHIC MAGAZINE

FEBRUARY, 1920

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PUBLISHED BY THE
NATIONAL GEOGRAPHIC SOCIETY
HUBBARD MEMORIAL HALL
WASHINGTON, D.C.

$3.00 A YEAR 35c. THE COPY

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ORGANIZED FOR "THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

To carry out the purpose for which it was founded thirty-two years ago, the National Geographic Society publishes this Magazine. All receipts from the publication are invested in the Magazine itself or expended directly to promote geographic knowledge and the study of geography. Articles or photographs from members of the Society, or other friends, are desired. For material that the Magazine can use, generous remuneration is made. Contributions should be accompanied by an addressed return envelope and postage, and be addressed: Editor, National Geographic Magazine, 16th and M Streets, Washington, D. C.

Important contributions to geographic science are constantly being made through expeditions financed by funds set aside from the Society's income. For example, immediately after the terrific eruption of the world's largest crater, Mt. Katmai, in Alaska, a National Geographic Society expedition was sent to make observations of this remarkable phenomenon. So important was the completion of this work considered that four expeditions have followed and the extraordinary scientific data resultant given to the world. In this vicinity an eighth wonder of the world was discovered and explored—"The Valley of Ten Thousand Smokes," a vast area of steaming, spouting fissures, evidently formed by nature as a huge safety-valve for erupting Katmai. By proclamation of the President of the United States, this area has been created a National Monument. The Society organized and supported a large party, which made a three-year study of Alaskan glacial fields, the most remarkable in existence. At an expense of over $50,000 it has sent a notable series of expeditions into Peru to investigate the traces of the Inca race. The discoveries of these expeditions form a large share of the world's knowledge of a civilization which was waning when Pizarro first set foot in Peru. Trained geologists were sent to Mt. Pelee, La Soufriere, and Messina following the eruptions and earthquakes. The Society also had the honor of subscribing a substantial sum to the historic expedition of Admiral Peary, who discovered the North Pole April 6, 1909. Not long ago the Society granted $20,000 to the Federal Government when the congressional appropriation for the purchase was insufficient, and the finest of the giant sequoia trees of California were thereby saved for the American people and incorporated into a National Park.

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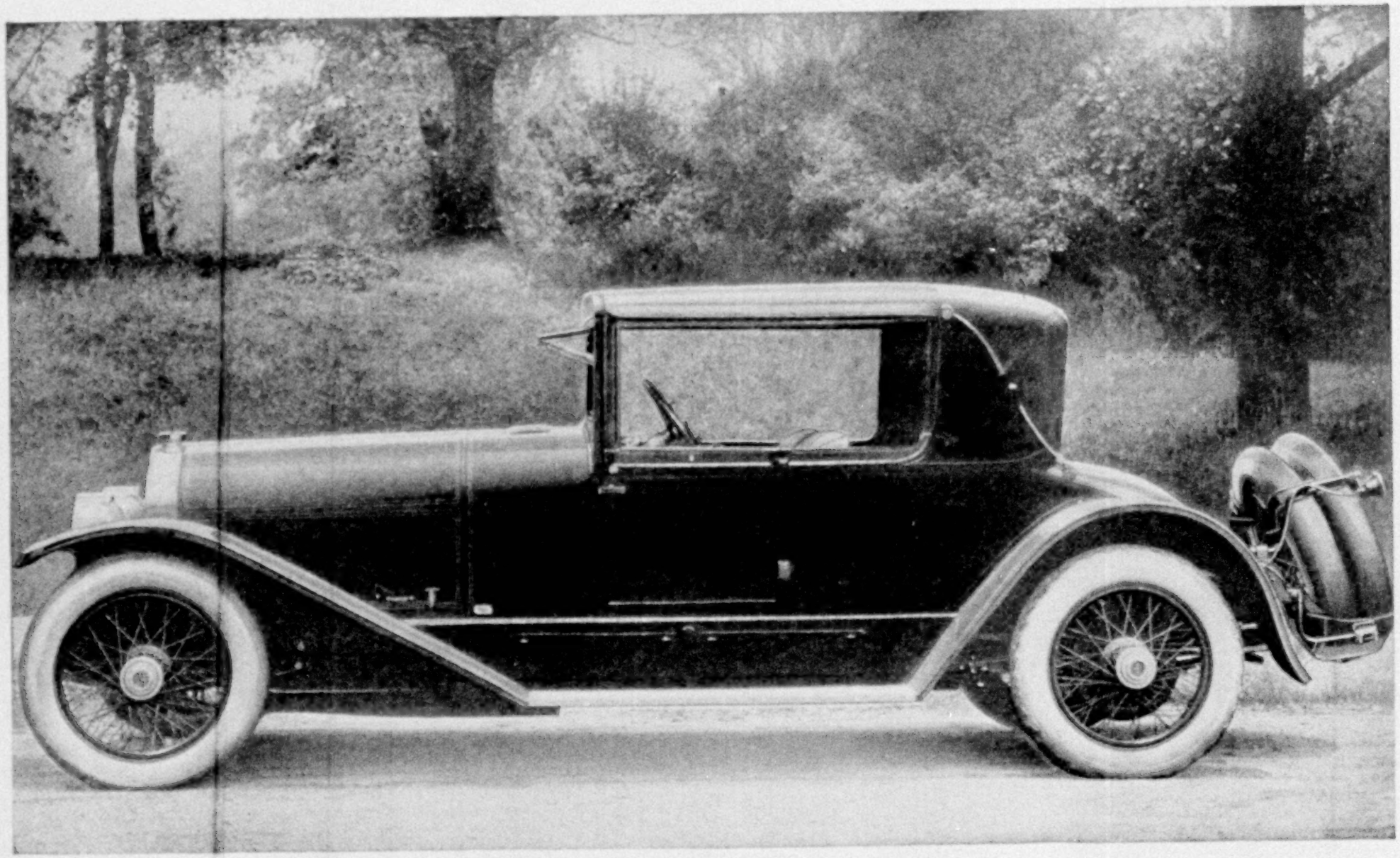
Entered at the Post-Office at Washington, D. C., as Second-Class Mail Matter.

Acceptance for mailing at special rate of postage provided for in Sec. 1103, Act of October 3, 1917, authorized July 1, 1918.



CONVERTIBLE LOCOMOBILE GUNBOAT CABRIOLET

THE *outstanding feature of the design is the extreme lowness of the car.*
The maximum height is less than six feet. Ample headroom is secured by countersinking the floor.

Custom design by THE LOCOMOBILE COMPANY OF AMERICA, Bridgeport, Conn.

Where your tire money goes when you skid–

Every time you skid you wear off miles and miles of tire service. It's like so many dollars being thrown in front of the street cleaner's scraper. Loss of traction always means loss of tire money.

Chief Engineer of the International Motor Company, A. F. Masury says:

"Sliding the wheels of railroad cars causes flat wheels. If sliding a hardened steel tire over a smooth steel rail for a few seconds can so abrade the wheel that its pounding will crack 150-lb. rails, fancy the damage to a rubber tire in skidding or sliding over a stone or concrete road.

"No matter how carefully and skillfully you drive when roads are wet and slippery, it is next to impossible to avoid skidding unless your tires are equipped with Anti-Skid Chains—such as Weed Chains."

Weed Anti-Skid Chains

For Protection and Preservation

Weed Chains insure safety, economy and tire protection
—Always put them on "At the First Drop of Rain."

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In Canada: Dominion Chain Company, Limited, Niagara Falls, Ontario

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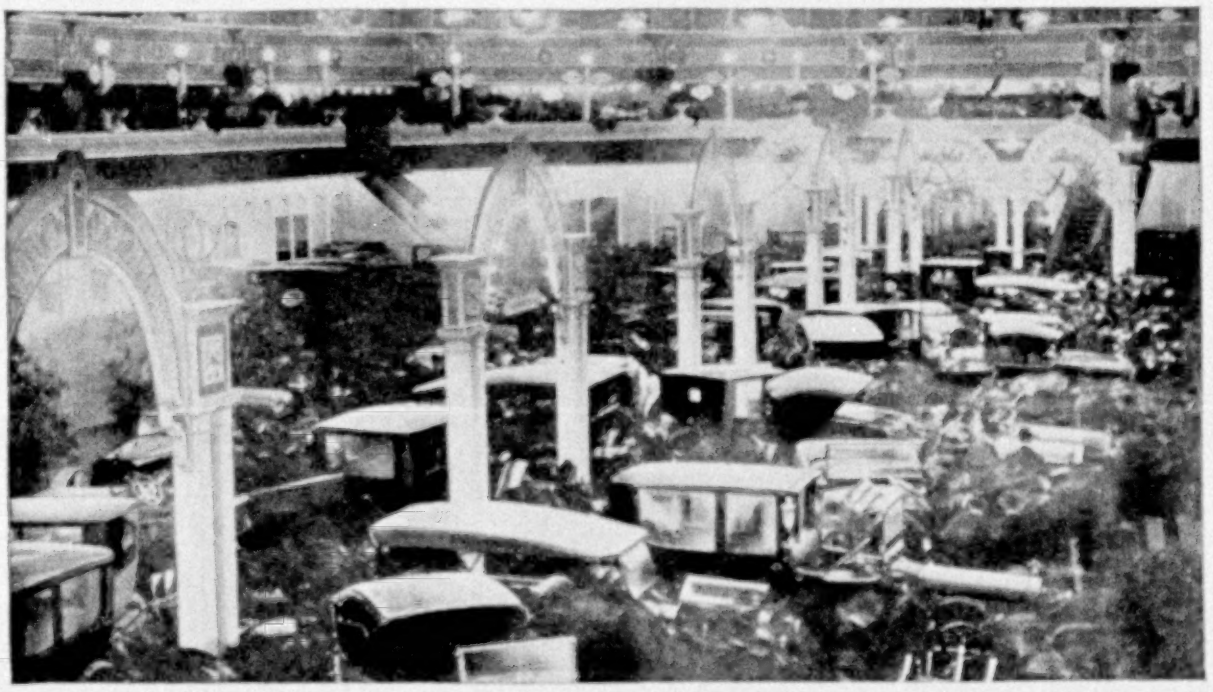


First night at the Automobile Show. Thousands of people pay admission to see new models of the year. A man can go all through the Show—see the new color schemes, ingenious novelties in trimming and design. What has he really learned?

What can a Man really Learn at the Show

THERE are a lot of things a man buys that he intends to discard after a season or so. He expects the style to change year by year. This is as it should be.

But no matter how much money a man has, when he makes a purchase involving perhaps $3000 and up, he expects to get a *reasonably permanent value.*

He usually gets it in everything but his motor car, where the habit of *style change* year after year may wipe out 27 per cent. of its value over night.

IF a car is expected to last only a year or two, there is no reason why its style should not change every season.

But the Packard Company believes that *stabilized style* is just as much a part of basic *transportation principles* as Packard mechanical features and performance.

The Packard car is built to deliver service over a *term of years.* Its style is no more subject to passing moods than its engineering design.

WHEREVER you go, you hear people say they see "so many Packards" on the street.

That is because the Packard keeps on running and is always a "new model."

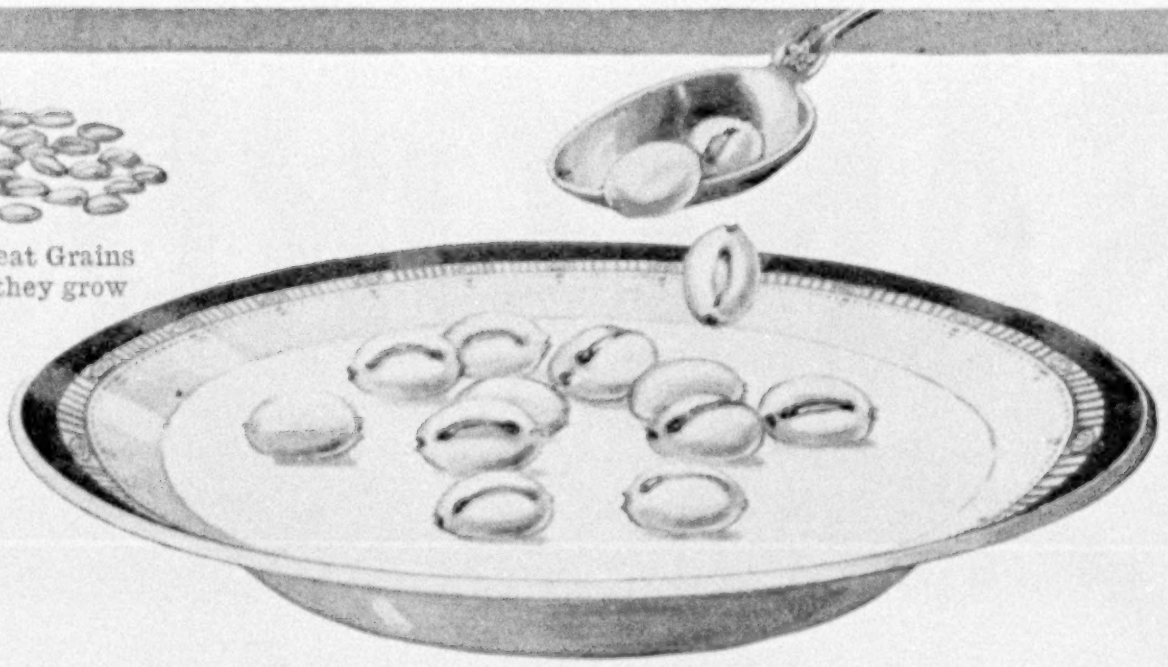
The public opinion about the Packard car is perhaps the most valuable automobile goodwill in the world.

"Ask the Man *Who Owns One"*

PACKARD MOTOR CAR COMPANY, *Detroit*

"Oh, Lord! A blow-out, no raincoat and five miles to the nearest town. Why didn't I have sense enough to put on Kelly-Springfields all around!"

Wheat Grains
as they grow



Witching Foods

But Also Scientific

Corn Puffs

These bubble grains—flimsy, flaky, toasted—seem simply tidbits to enjoy.

They seem to breakfast what dessert is to a dinner—a delightful garnish.

But that's a wrong impression.

Puffed grains were invented by Prof. A. P. Anderson—a scientific man. And there's deep reason for them.

Puffed Rice

To Make Whole Wheat Digest

Take wheat, for instance—a premier grain. Nature stores minerals in the outer coat, and other needed elements. Without them children suffer.

Yet that outer coat, under usual methods, goes largely undigested.

Prof. Anderson's method applies to wheat an hour of fearful heat. Then the grains are shot from guns. Thus 125 million steam explosions are caused in every kernel. And every food cell is so blasted that it easily digests.

Thus every atom feeds. This whole-wheat food means whole-wheat nutriment.

So with Puffed Rice—so with Corn Puffs. The food cells are all broken. The result is airy, nut-like globules—fascinating foods. But also foods which yield their precious elements.

Puffed Wheat Puffed Rice Corn Puffs

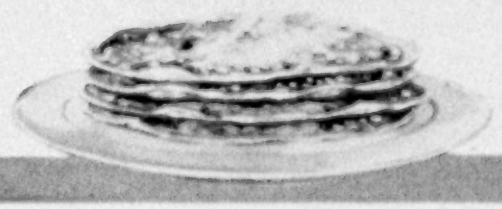
Also Puffed Rice Pancake Flour

The Quaker Oats Company

Sole Makers

Like Nut-Made Pancakes

Our food experts, after countless tests, have made an ideal pancake mixture. And they mix in it ground Puffed Rice. The result is flaky pancakes and a very nut-like taste. The finest pancakes ever served are made with Puffed Rice Pancake Flour. Try it. The flour is self-raising, so you simply add milk or water.



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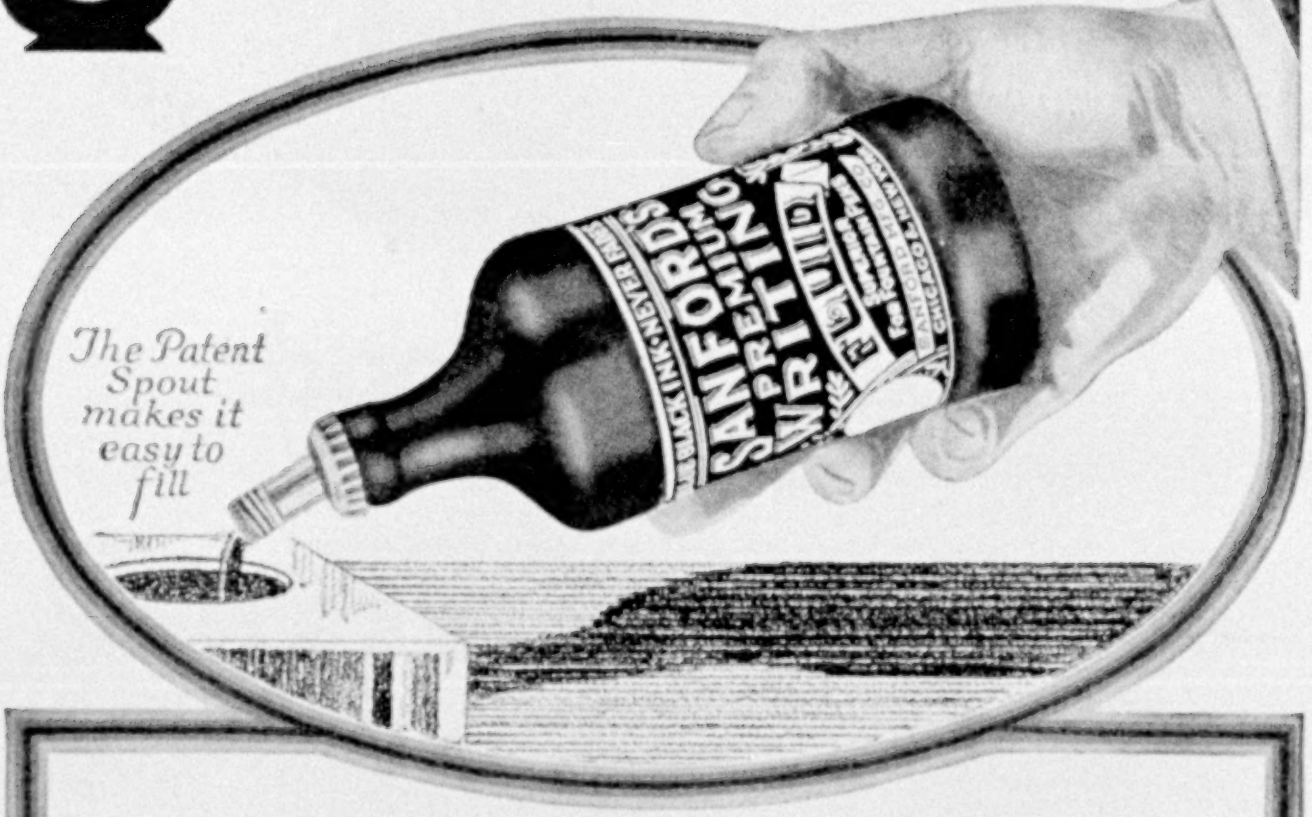

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Writes a Bright Blue

Changes to an everlasting black

NEVER FADES

For sale by all stationers

Do You Know Hudson

But Through Sheer Merit Alone Essex Made Its Thirty Million Dollar Sales Record

Builds the Essex?

Essex success has not been accidental. No one doubts its right to the position it holds.

But how many know why Essex in its first year revealed qualities more mature, more evident of the influence of long experience, than is commonly found in cars even in their third and fourth year.

You will recall the Essex was announced one year ago without one word as to the identity of its builders. Not a claim was made for its performance.

You were asked to go look at it, take a ride and form your own opinion. The Essex, we said, would have to speak for itself.

Now that it has established itself, we reveal why Essex has all the qualities of cars of long development.

Was Designed by Hudson Engineers

They conceived it as they developed the Super-Six. All they learned about endurance, they incorporated in the Essex.

They gave to the Essex the power that has made it famous in all quarters. Its speed is the result of what had been learned in making the Super-Six winner of all worthwhile speed records.

The Essex can never be all that the Super-Six is, for they are totally different types.

But the Essex does bring quality and performance to a class field that was unknown.

The former owners of large costly cars that have adopted the Essex have not been Hudson users. They have come from other cars, cars that fall short of the Super-Six in all particulars save size and cost.

The Essex appeals to such users because of its nimbleness. They like the way its performance compares with that of the Super-Six. You can see this on every hand. The two cars in any community that are most prominent because of their performance ability are the Hudson Super-Six and the Essex.

Essex Did Not Need Hudson's Endorsement

Think of the advantages Essex has had. What ordinarily would have required years to perfect was made possible in the very first model.

That is why 20,000 are now running, why more than $30,000,000.00 was paid for Essex cars in ten months.

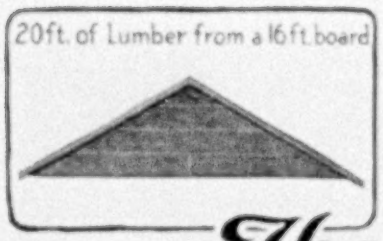
You have not needed the Hudson endorsement to understand Essex performance.

Essex has won its own way. Hudson gave it full benefit of the experience of its engineers and the ability of its manufacturing organization. Its name was not needed.

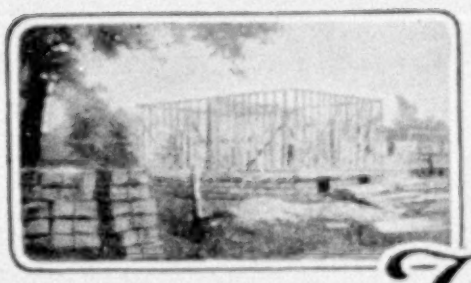
Now Hudson takes the same pride in acknowledging its kinship to Essex that a father might in speaking of his son who on his own account had made good.

"Mention The Geographic—It identifies you"

How to Reduce Present Home Building Costs



The System



The Result

$100 MINUS LABOR WASTE $70

Save the Waste and Reduce the Cost

The Aladdin System Scientifically Prepares the Materials and Conserves the Labor. You Can Save 18% of the Lumber and 30% on the Cost of the Labor.

$100 MINUS LUMBER WASTE $82

Certified records of thousands of Aladdin Homebuilders in every state prove these statements. You can prove these statements for yourself, for there is an Aladdin Home near you wherever you live.

The pictures above tell the story of scientific preparation and handling of materials and the efficient conservation and direction of the labor. The Lumber that's Wasted Costs Just as Much as the Lumber that's Used. The only possible way to reduce present high prices of lumber and labor is to save the usual waste. The Aladdin System prepares all the lumber in our mills ready to be nailed in place. Waste of lumber is reduced to less than 2%.

Greatest Distributing System of Lumber in the World

Aladdin houses are manufactured and shipped direct from the Aladdin Company's own Mills in Michigan, Mississippi, North Carolina and Oregon. Wherever you live Aladdin Houses come to you in a straight line from the nearest timber region.

Aladdin's National Homebuilding Service means shorter routes, quicker delivery and lower freight rates for builders in every part of the United States. Complete Sales and Business offices are maintained in connection with each mill.

Aladdin Readi-Cut Houses Include All Material Cut-to-Fit Complete

The Aladdin Book of Homes has a message for you. Amongst its pages, profusely illustrated in colors, leading home designs are represented to you. Aladdin houses are cut-to-fit as follows: Lumber, millwork, flooring, outside and inside finish, doors, windows, shingles, lath and plaster, hardware, locks, nails, paint, varnishes. The material is shipped to you in a sealed box-car, complete. Send today for a copy of "Aladdin Homes" No. 904

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Portland, Oregon
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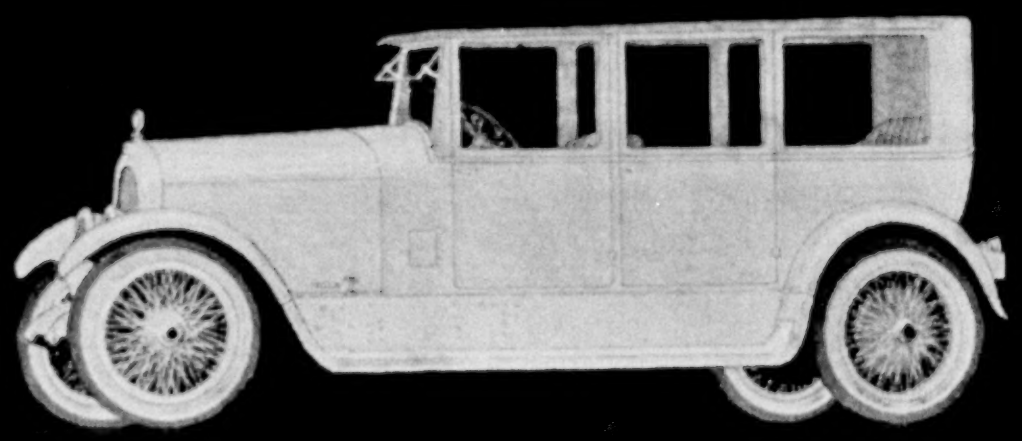
←Write to Nearest Office

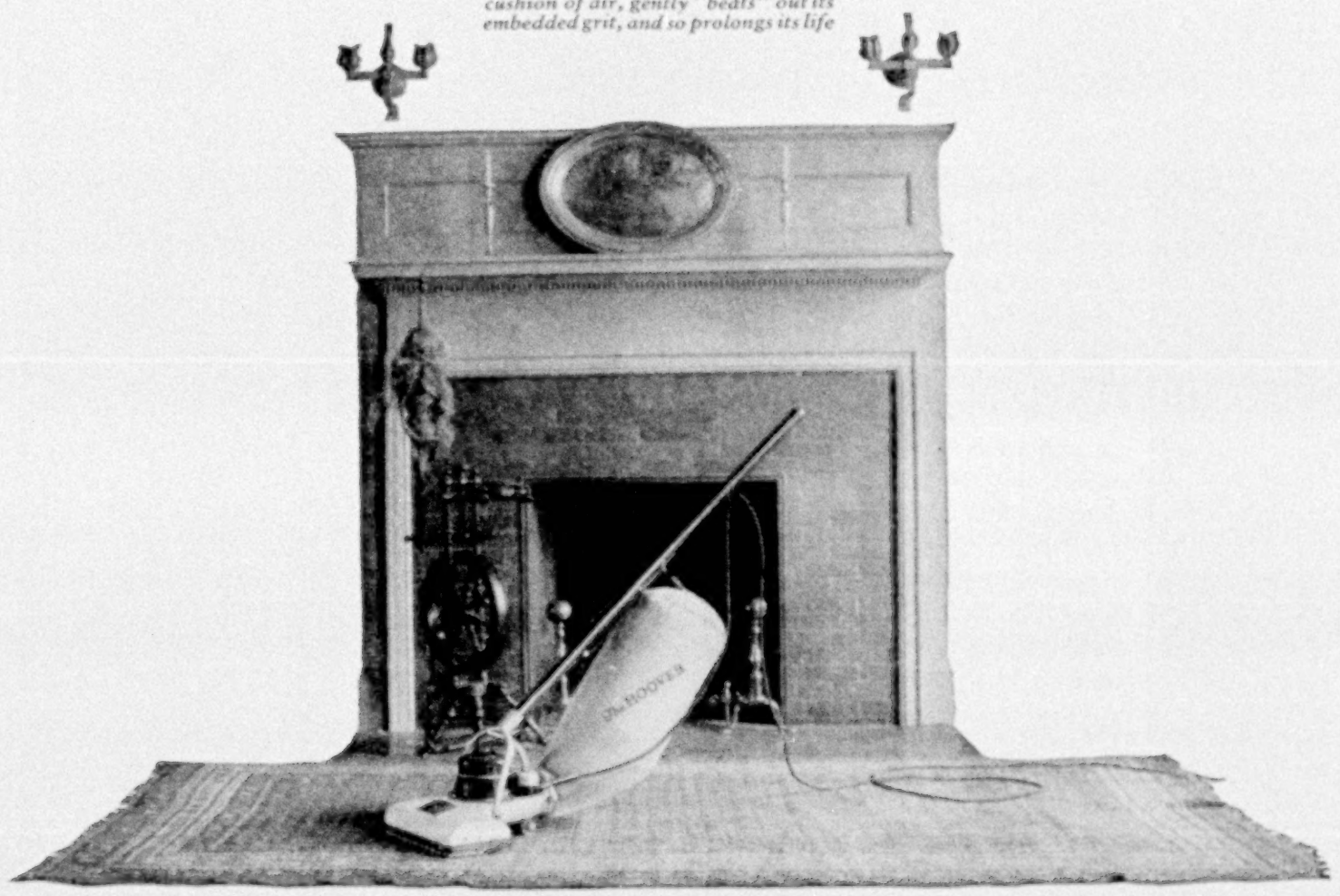
MARMON 34

The experience gained, and the organization developed, in building the Liberty Motor for the United States Government, has enabled this Company to produce a motor car built to the accuracy and "close limits" attained for the first time in Liberty Motor production. Advanced design and preciseness in manufacture accomplish new results in power, smoothness, economy, and long life.

NORDYKE & MARMON COMPANY
Established 1851 :: :: INDIANAPOLIS



The Hoover lifts the rug from the floor, like this — flutters it upon a cushion of air, gently "beats" out its embedded grit, and so prolongs its life



The costliness of rugs today makes advisable their careful preservation. Frequent and thorough cleaning prolongs their years of usefulness and beauty. Such cleaning consists of three essentials: Beating—to dislodge destructive embedded grit; Sweeping—to straighten crushed nap and detach stubborn clinging litter; Suction-cleaning—to remove surface dirt. Only The Hoover combines all three. And it is the largest selling electric cleaner in the world.

The HOOVER

It Beats—as it Sweeps—as it Cleans

THE HOOVER SUCTION SWEEPER COMPANY
The oldest makers of electric cleaners
North Canton, Ohio Hamilton, Canada

Picked By the Government Chosen By Big Business

GMC ¾ to 1 Ton Truck, Through Reliability and Endurance in War and Every-Day Commercial Use, Wins First Place as High Grade All-Purpose Truck

Since the very beginning of the motor truck industry the whole country has been looking for the all-around Truck.

Just as the ordinary, general-purpose wagon is the evolution into a standard design of many varying types, men have expected a standard all-purpose truck to some day be developed.

This long-expected product of experience in truck building and truck utility actually has arrived in the finished and proved design of Model 16, GMC ¾ to 1 Ton Truck.

Its makers, as happens in many a success, builded better than they knew. The ¾ ton GMC took hold and reached out away beyond even what its designers had set as its standard of utility.

When trouble broke out on the Mexican border it was put into strenuous ambulance service. When the United States joined the Allies in the World War the GMC ¾ Ton Model was put into active service both here and overseas with high credit.

When the War Department sought to classify the various motor trucks according to a fixed number of standard models this GMC ¾ Ton Truck was picked as it stood for class AA in place of a design developed by Government engineers.

Again the GMC ¾ Ton Model had measured up to the need—it had done more, for its great margin of safety justified Government engineers in adopting it for both the ¾ ton and 1 ton classifications.

GMC Model 16 had speed and flexibility for the greatest range of action over roads of the most extreme character. It possessed the superstrength of chassis and developed motive power that enabled it to qualify in the one ton class.

The success of Model 16 is the outcome of a very definite principle—the principle that a truck will yield in service only according to the quality in its construction.

GMC Trucks are made by the General Motors Truck Company, the exclusive truck making unit of the General Motors Corporation. Behind GMC Trucks, then, is the backing of the strongest and most important organization in the automotive industry.

What the Government Did

Adopted GMC Model 16 just as it stood; as the AA standard for all military purposes in both the ¾ ton and 1 ton classes. Its record can be told by any returned soldier.

What Big Business Is Doing

Selecting GMC Model 16 in larger and larger numbers for both ¾ ton and 1 ton requirements, in fleets and for single truck service, proving by experience the correctness of the Government's judgment.

Model 16 is only one of the GMC Family, every member of which has equally as good a record

General Motors Trucks

GENERAL MOTORS TRUCK COMPANY
Pontiac, Michigan

(592)

You have a heart – is it a "regular" heart ?

UNDOUBTEDLY yes, and probably it is a first-class American Heart, the biggest heart in the world, fine, generous, sensitive, never refusing to respond instantly to endless calls for help; giving, giving, giving; jumping to obey your will for more energy, more power, more blood—to put life into your mental and physical activities, a red punch into every muscle, a tingle to every nerve, a grip to your hand, a vigor to your thoughts, sincerity to your sympathy—a *vital*, *human*, "regular" heart. Have you one?

Of course yes. But probably you never have given a thought to that marvelously made *engine* of yours, that *machine* that runs you, delicate, full of vital valves, and muscles, and a million throbbing cells. And probably you never will think of it until . . . . . it drops a beat.

The motor of your beloved car demands the garage constantly and gets the care it needs. But your *own heart* beats on, beats on incessantly. Now and then it waves a red flag before you. Half of the physical and mental ills of life are red-flag appeals of a tired heart. You know these danger signals, but do you *heed them?*

This advertisement is simply a humane suggestion. *Have a heart for your own heart*—that engine of your will. *Give* it a thought. Treat it at least as well as you treat the engine of your motor. Neglect it, overwork it too long, and it will cost you all joy in life.

Probably there is nothing the matter with *your* heart; but the absolute knowledge of a perfect, "regular" heart is an inspiration. It clears the road, lifts the speed limit, and sets you free.

And in this connection—

THE GLEN SPRINGS

WATKINS, N. Y. **ON SENECA LAKE**

The Pioneer American "Cure" for Heart Disorders

Not Glen Springs for a *new* heart, but Glen Springs for an intelligent looking over of your human machine, especially your heart—to detect and correct *in time*, to the best of human ability. And this ability of Glen Springs—its Nauheim Baths, diagnostic laboratories, X-Ray and scientific treatments, under noted specialists—is universally recognized in the medical world.

The Glen Springs is situated in the beautiful Finger Lake Region of New York State. Clear, dry, invigorating atmosphere. Every comfort and convenience. *Open the Year Round. Winter and Spring months, when the elements of oppressive weather are absent, are most desirable for heart treatments.*

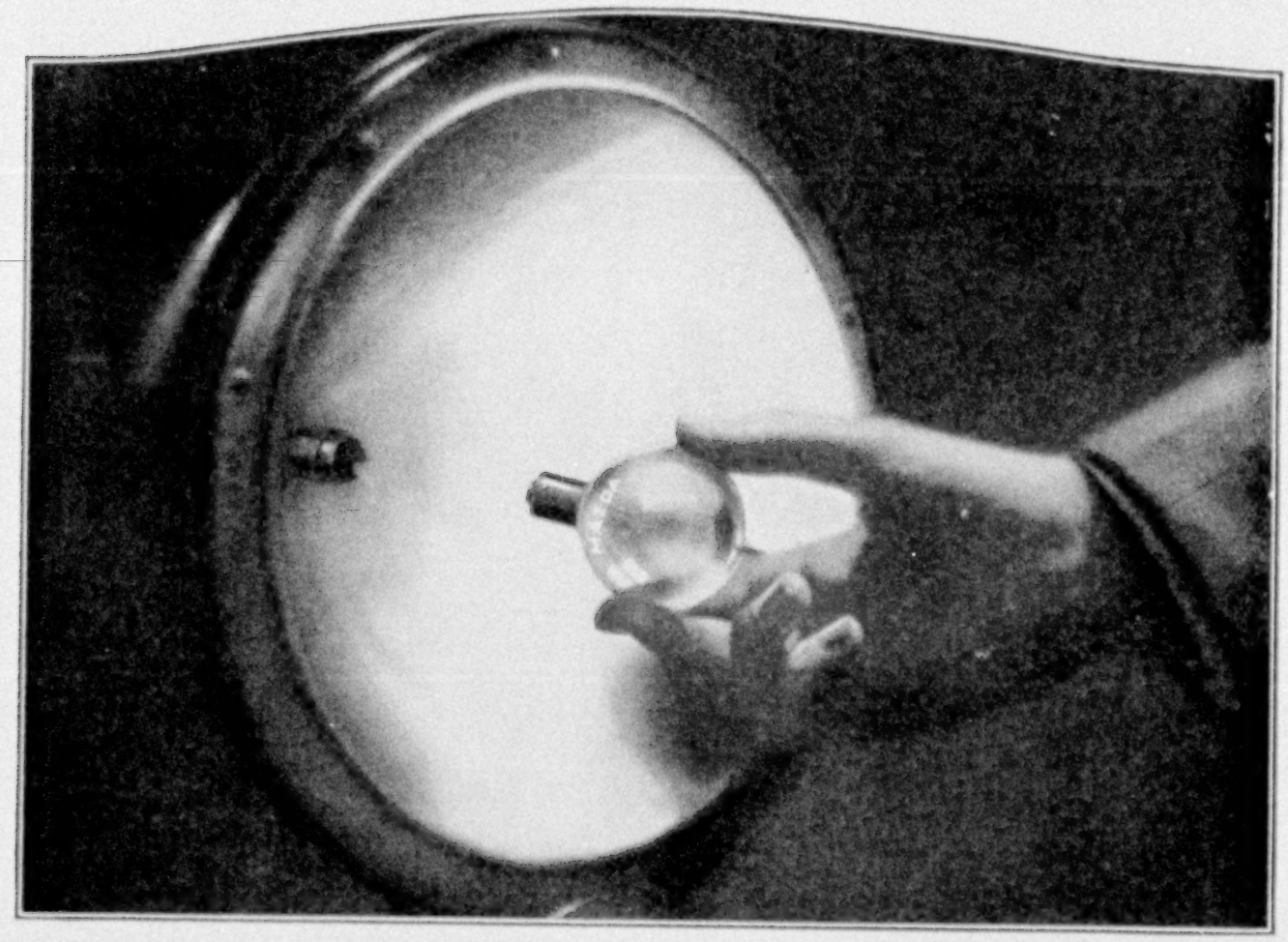
Be sure that your heart is a "regular" heart.

WILLIAM E. LEFFINGWELL, *President*

Illustrated booklets with detailed information on request

MAZDA

"Not the name of a thing, but the mark of a service"



Dependability or Doubt—Which do you put in?

Headlight dependability comes only when the lamp bulb itself is dependable. With the MAZDA Lamp, sun-like safety on night roads is assured through the reliability which MAZDA Service has put into every lamp marked MAZDA. Be sure the lamps on your car are marked MAZDA.

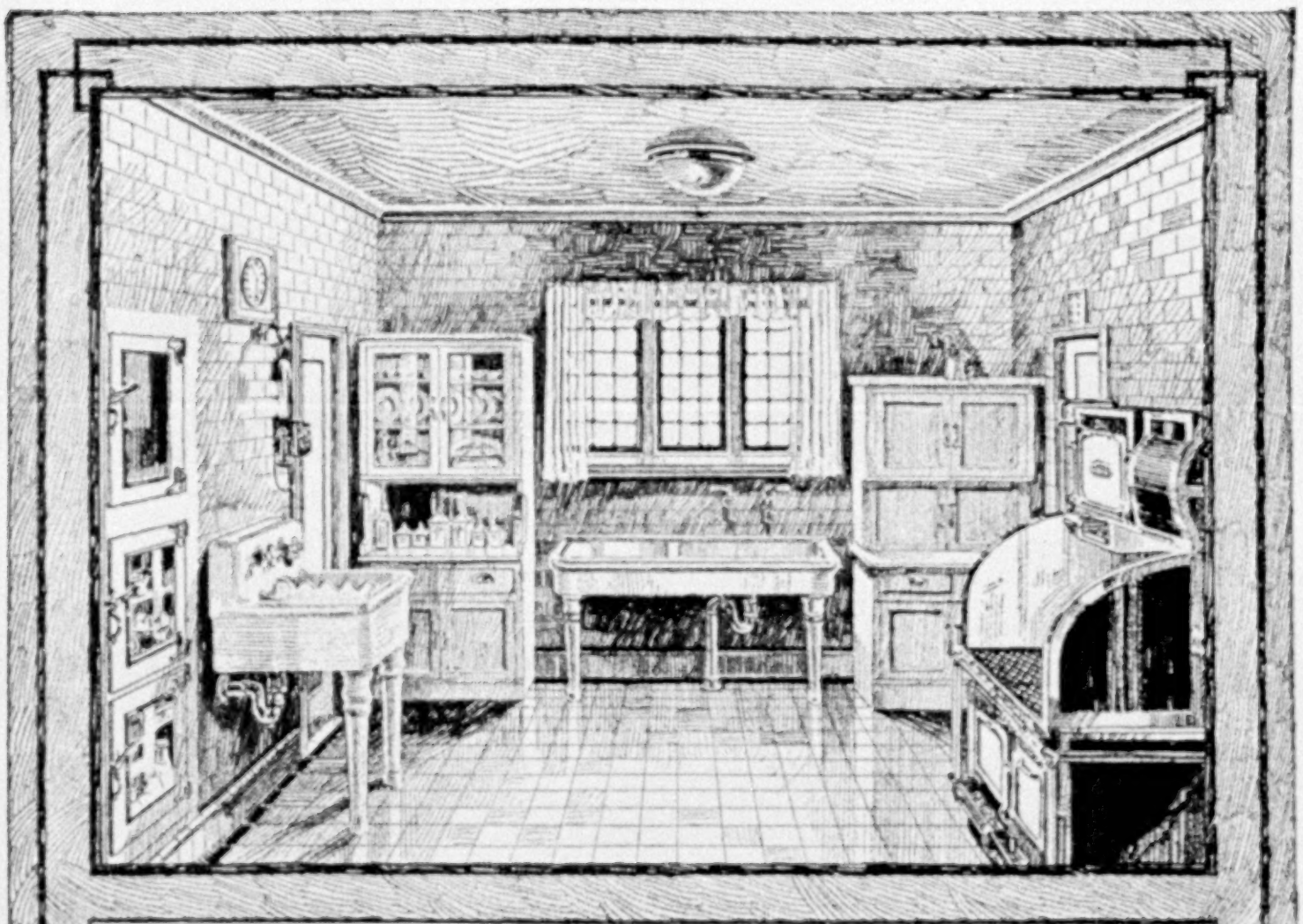
MAZDA is the trademark of a world-wide service to certain lamp manufacturers. Its purpose is to collect and select scientific and practical information concerning progress and developments in the art of incandescent lamp manufacturing and to distribute this information to the companies entitled to receive this service.

MAZDA Service is centered in the Research Laboratories of the General Electric Company at Schenectady, N.Y. The mark MAZDA can appear only on lamps which meet the standards of MAZDA Service. It is thus an assurance of quality. This trademark is the property of the General Electric Company.

RESEARCH LABORATORIES OF GENERAL ELECTRIC COMPANY

"Mention The Geographic—It identifies you"

XUM



Beauty Made Permanent

A distinctive merit in Crane kitchen equipment is that its original attractiveness, every detail of its alluring cleanliness and all of its carefully-designed sanitary features, are made permanent with minimum effort. It is naturally clean—and easily kept clean.

Crane Valve s are made in Types and Sizes to meet all Requirements.

CRANE

products embody the best materials and represent the highest craftsmanship. They are complete, convenient, durable—the choice of those who keep in mind that a well-ordered, sanitary kitchen is a pre-requisite of comfort in any household.

The same standards of quality and utility apply to Crane bathroom fixtures and heating, ventilating and vacuum cleaning systems. To assure conformity to these standards, heating, plumbing or sanitary accessories, not made by the Crane Co. itself, are made in many cases from their own specifications and designs. Illustrated Literature on Request.

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Springfield	Washington	Birmingham	Kansas City	Davenport	Watertown	Pocatello
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TO WHICH THE PUBLIC IS CORDIALLY INVITED

BRANCHES IN FIFTY-SIX LEADING CITIES + WORKS CHICAGO, BRIDGEPORT

Columbia Records

Columbia Records Grafonola

Charles Hackett, *American Tenor*

Newest Columbia Star

Here is a real American tenor. His brilliant career has already put him in the front rank of Grand Opera singers. The Columbia Graphophone Company is gratified to announce that this New York Metropolitan Opera Company star has agreed to make records for Columbia exclusively. His first are:

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Ask any Columbia dealer to let you hear these wonderful records

COLUMBIA GRAPHOPHONE COMPANY, New York

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CONNECTICUT IGNITION

How Connecticut Sparks Fire Those Cold Cylinders

THEY are intense sparks. Because they alone realize the full possibilities of your battery and coil.

For Connecticut need not sacrifice its current to reduce the danger of battery drainage.

When the engine stops with the current on, the Connecticut Automatic Switch absolutely cuts it off—eliminating all danger of wastage.

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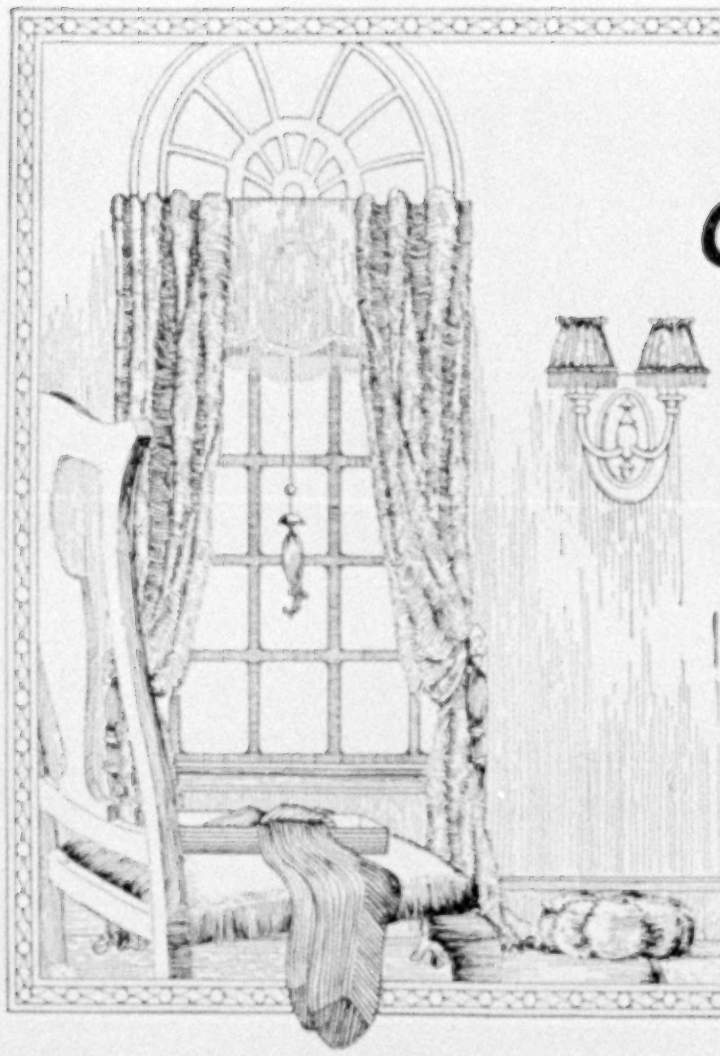

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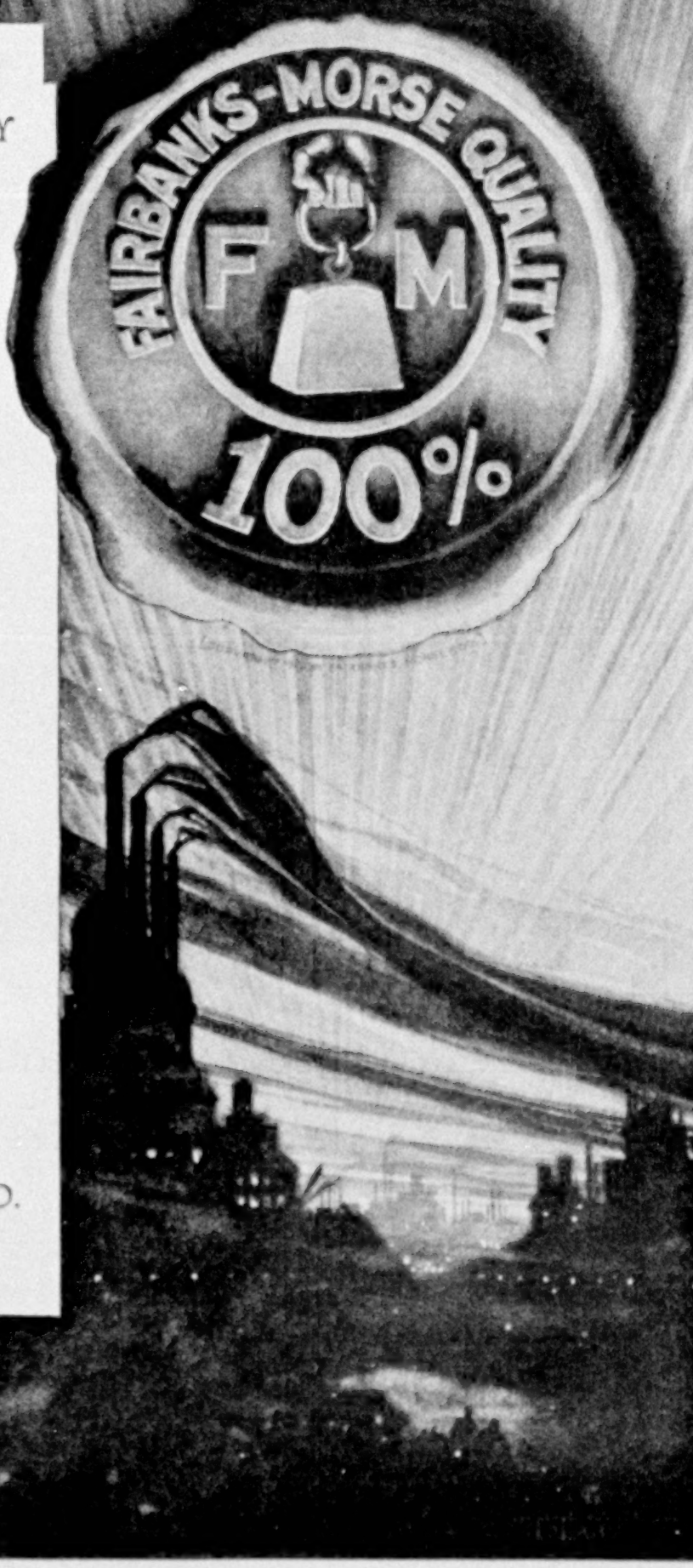

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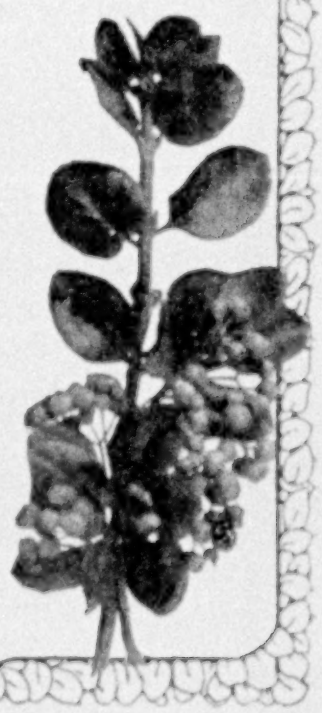

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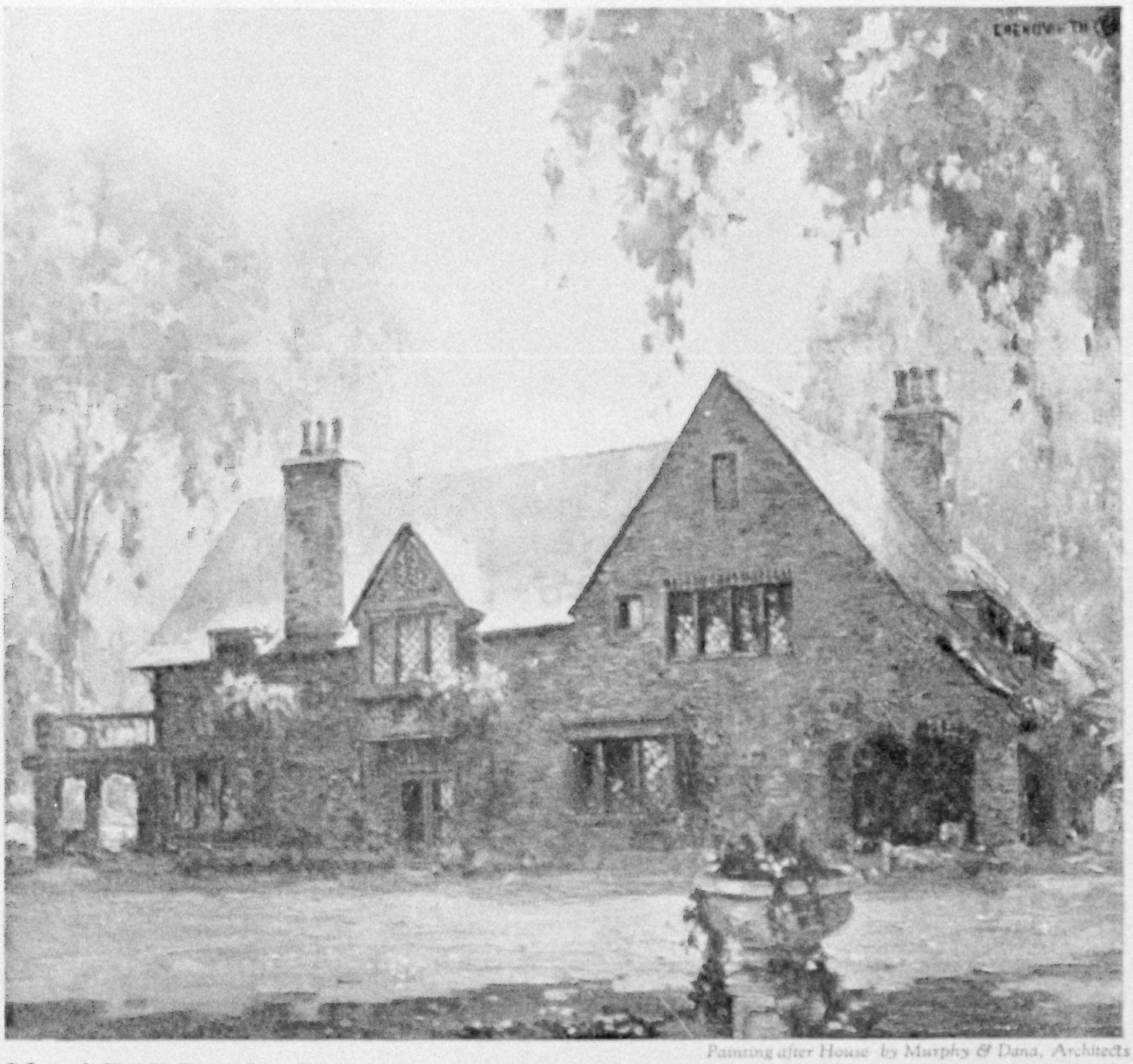

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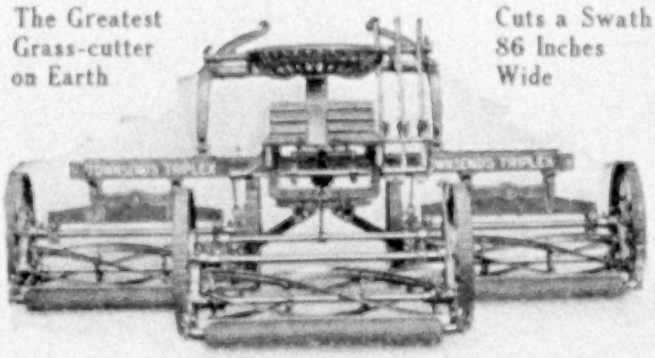

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VOL. XXXVII, No. 2 WASHINGTON FEBRUARY, 1920

THE NATIONAL GEOGRAPHIC MAGAZINE

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THE REMOVAL OF THE NORTH SEA MINE BARRAGE

BY LIEUTENANT-COMMANDER NOEL DAVIS, U. S. NAVY

Photographs from the U. S. Navy Department

For an account of the extraordinary feat of the U. S. Navy in planting 56,611 mines in the North Sea, the reader is referred to "The North Sea Mine Barrage," printed in THE GEOGRAPHIC, *February, 1919. The removal of the mines was perhaps an even more remarkable achievement, and was under the direct command of Rear-Admiral Joseph Strauss, who also had command of the expedition that laid the mines.*—THE EDITOR.

WHEN time and study have enabled an accurate history of the World War to be written, it is not at all unlikely we shall read that the North Sea Mine Barrage was primarily responsible for the collapse of Germany.

The inconceivably great task of closing the exits of the North Sea had been accomplished; an impregnable wall of mines stretching from Scotland to Norway, a distance of 240 miles, had become a reality, and that deadly weapon, the submarine, which had daily brought us nearer to inevitable defeat, regardless of the gallant efforts on the battlefields of France, at last was bottled up within the North Sea, no longer free to carry on its depredations.

The construction of the barrage was a magnificent achievement, typically American, demanding the concentrated efforts of many of our largest manufacturing establishments to produce the countless complicated parts which make a mine; the building of huge assembly plants in Scotland; a special fleet of mine-layers; and then, in the face of the enemy, the laying of these thousands upon thousands of delicately adjusted spheres, one at a time, each in its predetermined position in the North Sea.

The hitherto intrepid submarines were conquered, because they would not risk a passage across the barrage. Several tried and were destroyed; others, critically damaged, managed to reach port and told of this new danger which confronted them. And here it was that the barrage became most fruitful.

As long as the submarines had an even chance in battle, they were willing to continue. Now the realization was forced upon them that they faced an intangible foe, an ever-present foe, always waiting and ready to explode upon the slightest contact. Realization grew into fear, the fear to mutiny; new crews could not be mustered, and so the U-boat menace was ended.

WHEN GERMANY'S ONLY CHANCE OF VICTORY FADED

With the collapse of the submarine campaign, Germany's only chance of vic-

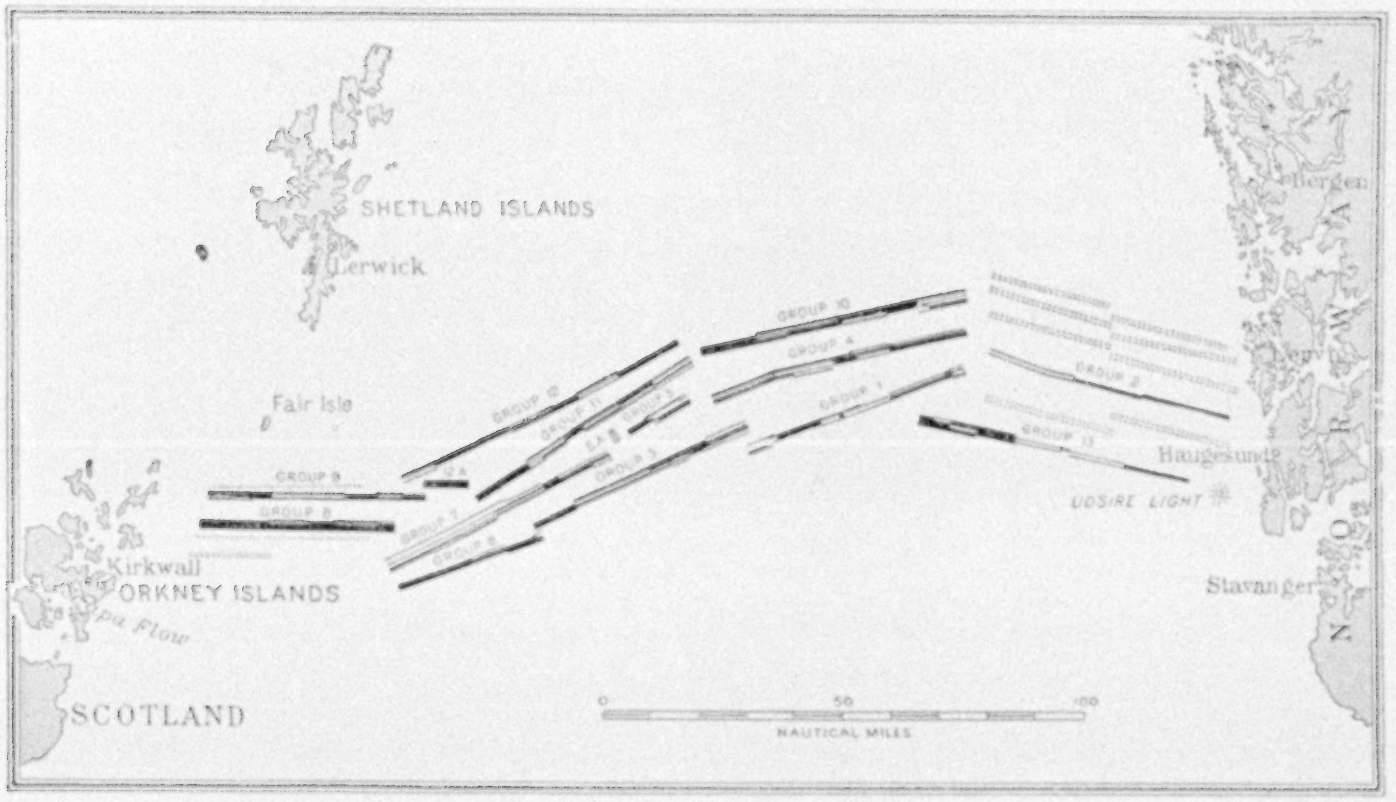
GENERAL MAP SHOWING THE LOCATION OF THE MINE FIELDS

The narrow Straits of Dover had been closed previously by mines and nets. With the completion of the North Sea Barrage, stretching from Norway to the Orkney Islands, the fate of the German submarine was sealed.

tory faded. She knew it better than we, and at once circuitously sent forth her first proposals for peace, which developed with such remarkable rapidity that a few weeks later the Armistice was signed and the war was over.

Then came the period of reconstruction, with tasks almost as great as those of the war itself. The havoc and devastation had been frightful. Cities and farms without number must be rebuilt, millions of starving people had to be fed, and, perhaps most immediately serious of all, the thousands upon thousands of mines which had been laid must now be cleared away, in order that the countless vessels loaded with food and troops might navigate in safety the long-obstructed ocean highways.

Concentrated in the North Sea Barrage



DETAIL MAP OF THE MINE GROUPS

The mines laid by the United States Navy are represented by full lines, and are further distinguished by group numbers. The broken lines indicate the mines laid by Great Britain.

were more than 70,000 mines—more than had been laid during the entire war in all the other waterways combined—and of these slightly better than 80 per cent had been laid by the United States Navy during the six months preceding the Armistice. Now, with the arrival of peace, we had accepted the responsibility of removing every mine that we had laid.

Think what it meant. Here was a death trap containing more than 21,000,000 pounds of TNT and extending over an area of approximately 6,000 square miles! This mighty belt of destruction had plucked from Germany her only hope of victory, because the crews of her submarines, after losing their comrades, who tried in vain to cross it, mutinied and refused to risk their lives in what appeared a certain death (see maps, pages 104 and 105).

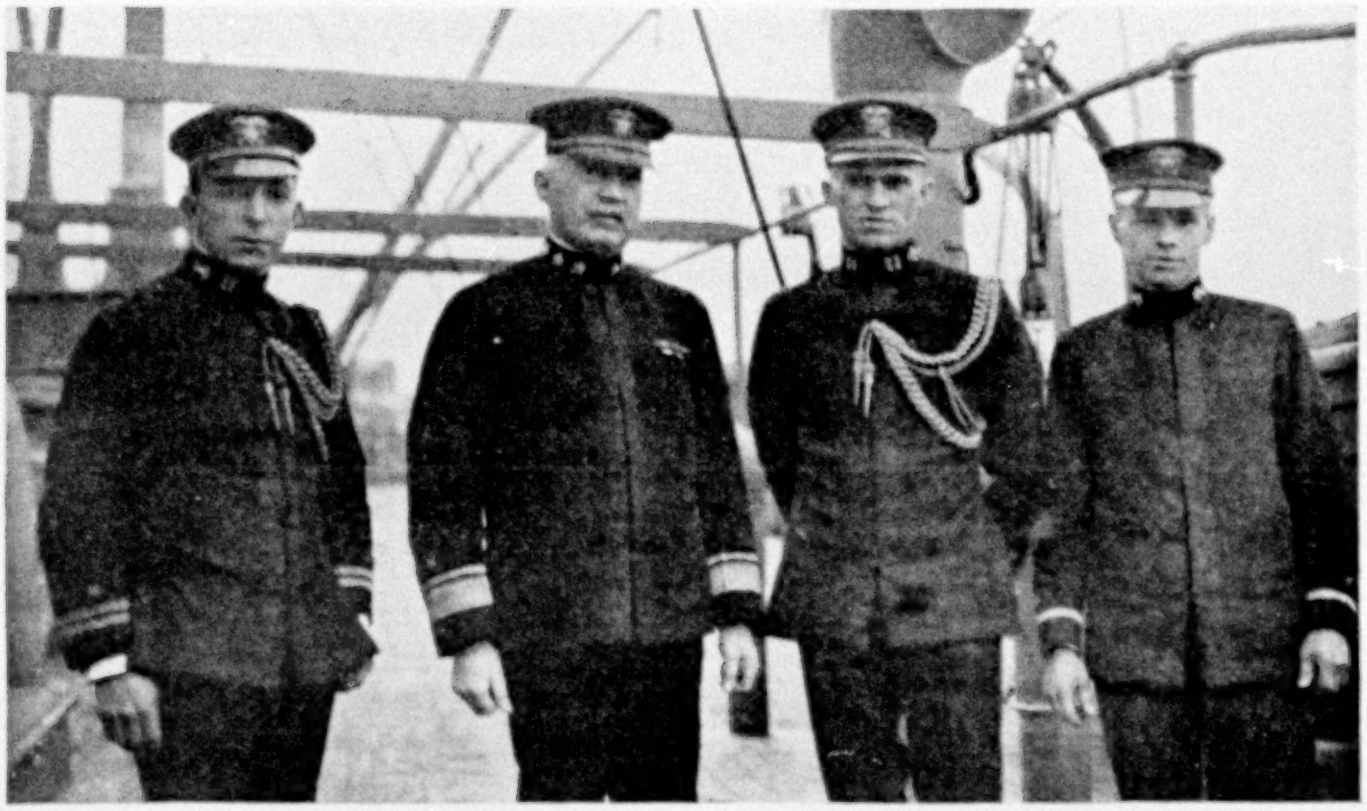
Although the Germans had learned the secret of our mines within a month after the first one was laid, they were unable to devise any means of safeguarding their ships to prevent them from exploding these delicate weapons—weapons which now confronted us with all the potential destruction that had been designed to subdue an enemy.

We had veritably sown our wild oats, and now we had to reap them; for the only means of removing the mines was to cross and recross the mine fields, time after time, until we were sure that not a single mine was left.

HOW MINES ARE SWEPT

Sweeping mines, for by such name is the process of removing them called, is not a particularly intricate art. It consists essentially in dragging a heavy wire between two vessels. In order to bury the wire to a sufficient depth beneath the surface to insure catching the mines, "kites" are attached to the sweep-wire just astern of each vessel. These kites fly down in the water in much the same manner that an ordinary kite flies up in the air (see page 108).

When a mine is caught in the sweep-wire, it is dragged along until the slender wire which holds it to its anchor breaks, allowing the mine to rise to the surface, where it is destroyed. This is ordinarily done by puncturing it with rifle-shots, so that it sinks and becomes innocuous. No



REAR-ADMIRAL JOSEPH STRAUSS AND HIS STAFF ON BOARD HIS FLAGSHIP, THE "BLACK HAWK"

Left to right: Lieut.-Commander Noel Davis, Rear-Admiral Joseph Strauss, Lieut. W. K. Harrill, and Ensign K. C. Richmond.

MARKER BUOYS TO INDICATE THE POSITIONS OF THE LINES OF MINES WERE PLACED AT INTERVALS OF THREE MILES THROUGHOUT THE LENGTH OF EACH GROUP

Besides a differently arranged flag, each buoy was painted to show which line of mines it marked and its position in the group, in much the same manner that the signs on the street corners indicate the streets. The buoys were assembled on board, using the spherocylindrical cans which are seen on the stern of the ship.

attempt is made to recover the mines, for the risk involved is far greater than the mine is worth (see pictures, pages 110 and 116).

During the war the German submarines laid hundreds of mines in the entrances to European harbors, and toward the end had scattered some along our own Atlantic coast. Permanent sweeping forces were required to keep the channels cleared, and, while vessels so engaged were occasionally lost, our chief concern was from a totally different source.

These mines which Germany had laid, likewise the British mines, were what is known as the "horn type." Leaden horns project from the mine and must be struck and broken before the mine explodes.

Our mine was different. Invented shortly after the United States had entered the war, it had made the construction of the North Sea Barrage possible. A piece of metal the size of a nail was sufficient to explode it. Furthermore, a long antenna stretching up above the mine enormously increased its radius of action. Vessels built of anything but wood could not survive in such a field. Even the sweep-wire was sufficient to detonate the mine, and, worse, one mine frequently caused other mines to countermine, and if one of these should be beneath a sweeper——!

THE MAN CHOSEN FOR THE INTRICATE TASK

The task before us indeed was delicate. It called for concentrated genius and iron-handed resolution to tackle such a problem, and Rear-Admiral Joseph Strauss, United States Navy, was selected for the job. Possessing an intricate knowledge of explosives and their caprices, a knowledge derived from long periods of duty in the Bureau of Ordnance, and having personally directed the actual construction of the barrage, he was, without qualification, the one man in the Navy best suited for such an exacting undertaking. But even he didn't have the faintest idea what the ultimate method of sweeping would be.

Every possible scheme must be tried with the hope of finding a solution—a solution not only for clearing the mines in the shortest possible time, so that shipping might resume its normal routes, but, primarily, one which would afford the maximum safety to the men who were to be engaged in this hazardous work, for human life had at last returned to par.

The first thing to be done was to ascertain the then existing condition of the barrage.

It was now December. The mines had been laid from three to six months. In order to limit the depredations of the U-boats as quickly as possible, it had been necessary to lay these newly developed mines without subjecting them to the exhaustive tests so essential to the logical development of all intricate and delicate mechanisms. Perhaps the firing batteries had become exhausted or some other unforeseen defect had rendered them inactive. This we must know at once; for, aside from the shortness of the winter days in such high latitudes (60 degrees north), gale follows gale with such rapidity that small craft are scarcely ever safe, and sweeping during the winter would be impossible.

If we were to complete our task during the coming summer, everything must be in readiness to begin active operations at the first break of spring.

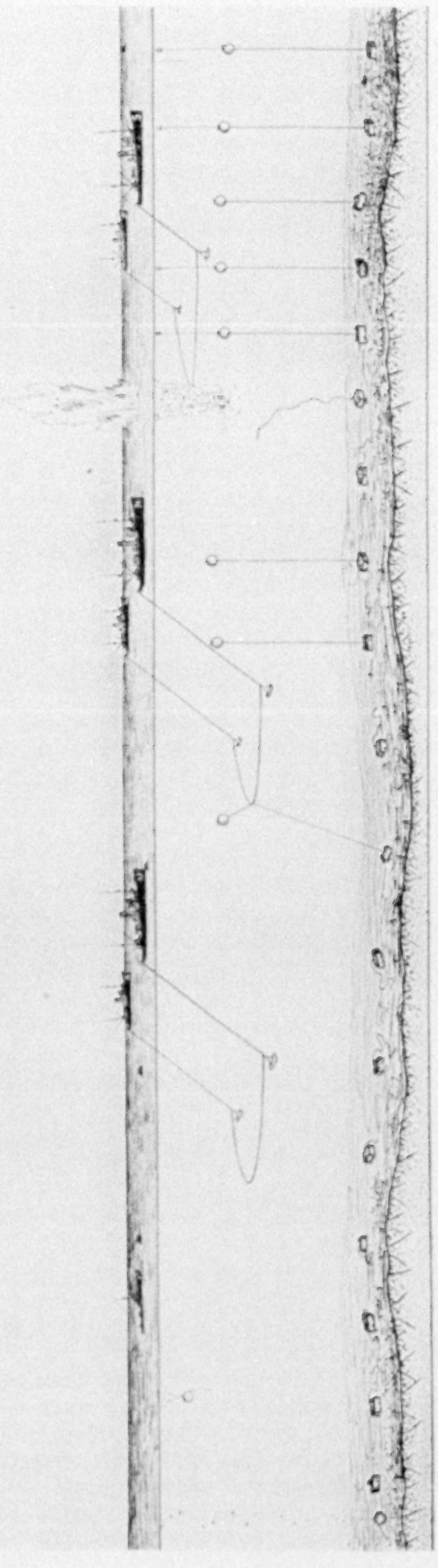
MAKING SAILING-SMACKS MINE-PROOF

Steel vessels could not, of course, be used for this first experiment, and self-propelled wooden vessels invariably have so many iron fittings about their hulls that they, too, would be in constant danger. Admiral Strauss therefore borrowed from the British two of the only type of vessels left—wooden sail-boats sixty-nine feet long.

Sweep mines with these? The idea was discouraged from the beginning. How could two small fishing-smacks, with their sterns tied together by a heavy sweep-wire, keep position on each other, pass sweep, and maneuver back and forth across the mine field? Ridiculous as the idea seemed, it was our only chance to gain the information that was needed.

The first step was to make them mine-proof, as far as such a thing were possible. They were hauled out upon the ways at Inverness, the hulls inspected, nail-heads driven in and plugged, and other metal fittings sheathed with wood.

XUM



Drawing by Noel Davis

DRAWING SHOWING THE LOCATION OF MINES UNDER THE SURFACE OF THE WATER AND HOW SWEEPING IS ACCOMPLISHED

There were, on the average, five parallel lines of mines in each of the thirteen groups laid by the U. S. Mine Force. Each of the five lines was swept, as shown above. The leading pair of sweepers regulated their sweep so as to touch only the antennæ of the mines, and in this way exploded as many as possible. The next pair of sweepers set their sweep to a greater depth, so as to saw the mooring of the remaining mines, and the last pair followed in their wake to catch any mines which might have been missed and to replace either of the leading pairs in case their sweep was broken. The sub-chaser, astern of all the sweepers, sank the mines cut adrift as they rose to the surface (see page 110).

They then were given a heavy coating of tar.

Manned with volunteer crews, these little vessels, the *Red Rose* and the *Red Fern*, got under way from Inverness with the two tugs, *Patapsco* and *Patuxent*, at sundown, December 22, 1918.

The *Patuxent* and *Patapsco* were to escort them as far as the mine fields, stand by while the experiments were being made, and then give them assistance, if required, when they again were off the field.

THE FIRST MINE EXPLODES

The next morning found the *Red Rose* and *Red Fern* on the southern edge of the barrage. There was a threat in the air as the little vessels stood up to each other, passed the sweep, and headed across the lines of mines; low-flying black clouds scudded rapidly across the gray sky, while the barometer went down with alarming rapidity.

Then, grr-ung!

A towering column of white water impelled by the explosion of 300 pounds of TNT sprang high above the masts of the *Red Rose*. Separated by only a short length of manila rope, which insulated the sweep-wire from the ship, the explosion virtually lifted the little vessel from the water, shaking her until it seemed as if the timbers in her hull would fly apart. When she settled down again the sea gushed in between the planks until the pump could scarcely keep the vessel dry.

This was the first mine. Five others followed, most of them, fortunately, further astern. It was indeed a pretty sight to see these

tiny vessels tacking and wearing in perfect unison, keeping station on each other by furling topsails or streaming sea anchors.

But the experiments were cut short by the gale foretold by the morning's sky, which broke with the fury of a hurricane in the early part of the afternoon. The sweep was cut adrift, sails reefed, and course set to pick up the *Patapsco* and *Patuxent,* who by now had been left out of sight beyond the horizon.

EXPERIENCING ONE OF THE GALES THAT MAKE THE NORTH SEA NOTORIOUS

By 3 o'clock the sun had set and the oncoming darkness added to the difficulties. Shortly before midnight the tugs were overtaken, but they were suffering equally in the gale, and a few minutes later were again out of sight.

How it blew! The *Red Rose* was hove to under storm-jib and staysail forward and triple-reefed mizzen aft. First, the jib went, followed by the topmast, then but a bare pole. A few hours later the mizzen-boom snapped, and for the next 36 hours the *Red Rose* wallowed in the North Sea waves—vicious waves, that seemed to come at once from all directions.

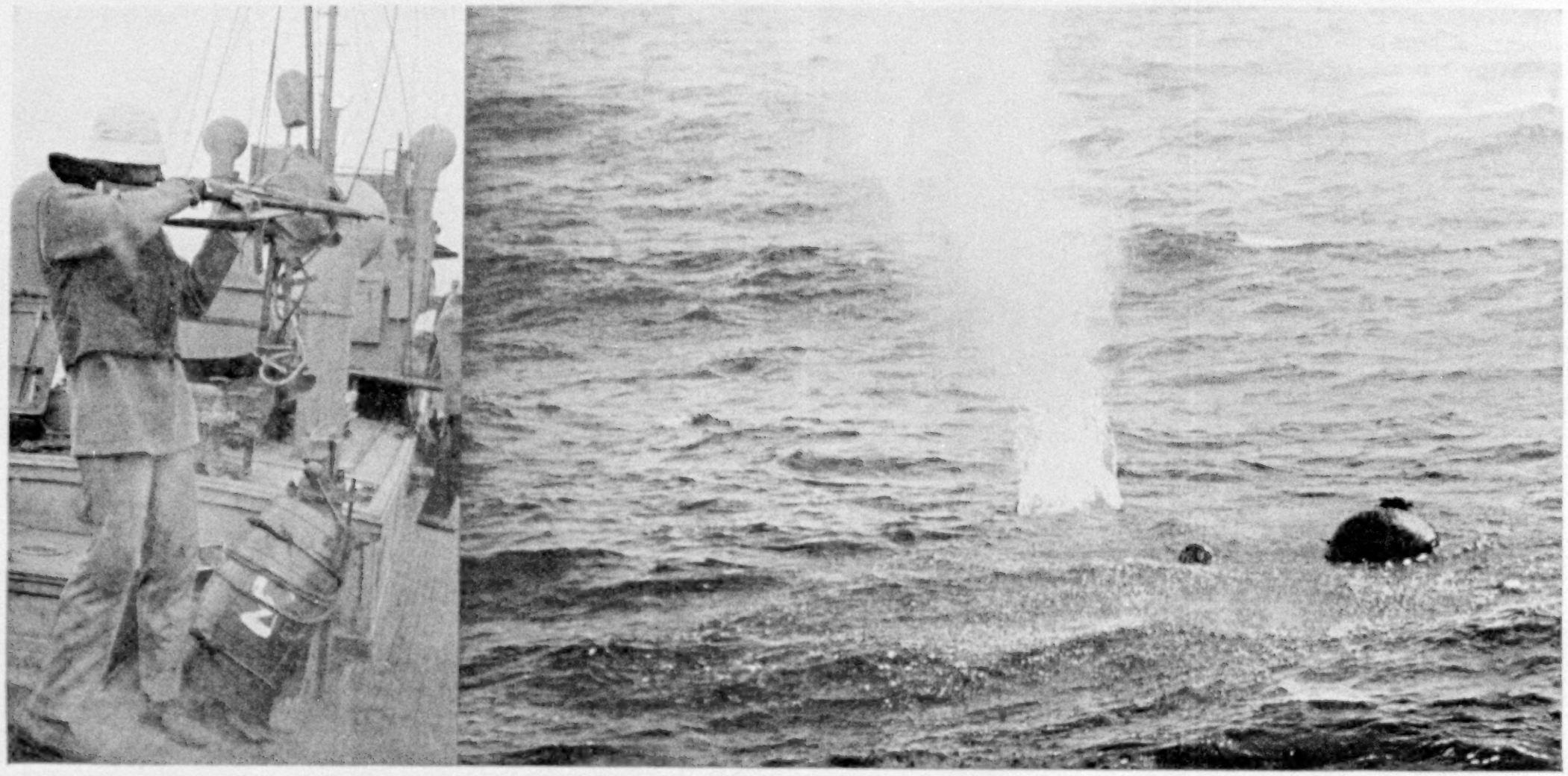
The *Patuxent's* rudder was carried away, and she had to return to port.

Not knowing whether the *Red Rose* and *Red Fern* were safe, a number of British men-of-war were sent out to join the search, but most of the would-be rescue ships had to return to port, for they could not weather the gale.

Then followed days of anxiety at Inverness. Had it been asking too much of such fragile craft to undertake this expedition at this period of the year? The North Sea is notorious the world over for its violent weather. But, when hope had almost ebbed away, word came from Peter-

BETWEEN THE STERNS OF THE TWO SWEEPERS IS STRETCHED THE SWEEP WIRE, ADJUSTED BY MEANS OF THE KITES TO RIDE AT A DEPTH OF APPROXIMATELY 260 FEET (SEE DRAWING, PAGE 108)

These two vessels are a half mile apart. A mine has just exploded in the cod (the center) of the sweep.



WITH THE LITTLE SUB-CHASERS ROLLING HEAVILY IN EVEN THE SLIGHTEST SEA, THE ORDINARY RIFLE WAS FOUND MORE SUCCESSFUL THAN THE MACHINE-GUN FOR SINKING THE FLOATING MINES WHICH WERE CUT UP BY THE SWEEPERS

When the mine is struck a metallic ring is heard, much the same as in a target gallery. If the bullet misses, a small spout of water is thrown up where it strikes. The small float which supports the antenna of the mine can be seen to the left of the mine itself. The bullets open holes in the mine, which soon fills with water and sinks to the bottom.

head that the *Red Rose* had reached port on Christmas morning. The next day the *Red Fern* anchored in St. Andrews Bay, blown 200 miles from her destination.

So ended the first experiment on the mine fields. Six mines out of 56,000 had been destroyed—a negligible number, of course; but we had found what we had set out to find—the mines were still there, waiting for us now, as they had waited for the enemy's submarines previously.

To clear the whole barrage by means of sail-boats was, of course, impossible. From the outset Admiral Strauss realized that rugged, powerful vessels, able to keep the sea in practically all weather, would be required to do this work. Furthermore, the United States Navy at last possessed an ample fleet of vessels of this type, for almost every week one of the new mine-sweepers was being completed and placed in commission.

But here, again, we were confronted with that ever-baffling problem: How could we protect these vessels so that they could cross the mine fields and strike the mines without exploding them?

Sheathe them with wood? It would take a year to fit out the necessary ships, if it could be done at all. Paint them heavily with tar or other non-conductor? Not sufficient protection.

THE MIRACULOUS HAPPENS

It began to look as if the task were impossible of accomplishment. Then the miraculous happened. I can remember it as if it were yesterday. A timid knock at the Admiral's door and Ensign D. A. Nichols (now lieutenant) hesitated and came in.

"I have a scheme, sir," he addressed the Admiral, "for protecting ships against the mines; but it is so simple that I'm almost ashamed to suggest it."

It was simple, too, but one of those simple things which require the mind of a genius to discover. Fifteen minutes later the necessary gear to test the scheme was being assembled, and that same afternoon the tests were carried out—and were successful!

Our greatest handicap was now removed and we were free to use steel ships for sweeping the barrage as soon as they could be fitted with the Electrical Protective Device!

More exhaustive tests were carried out—rigid to a detail—to find if there were any points which had been overlooked; but every test proved even more conclusively the effectiveness of the device. Specifications for its construction were cabled to Washington and the actual manufacture began a few days later.

OUTFITTING THE MINE-SWEEPERS

Our most pressing task now was to get the new mine-sweepers, which were still scattered among the various ports on the Atlantic coast, equipped with this device, fitted with sweep-gear, provisioned for a long period away from home, and then get them started for the North Sea to begin actual work at the break of spring.

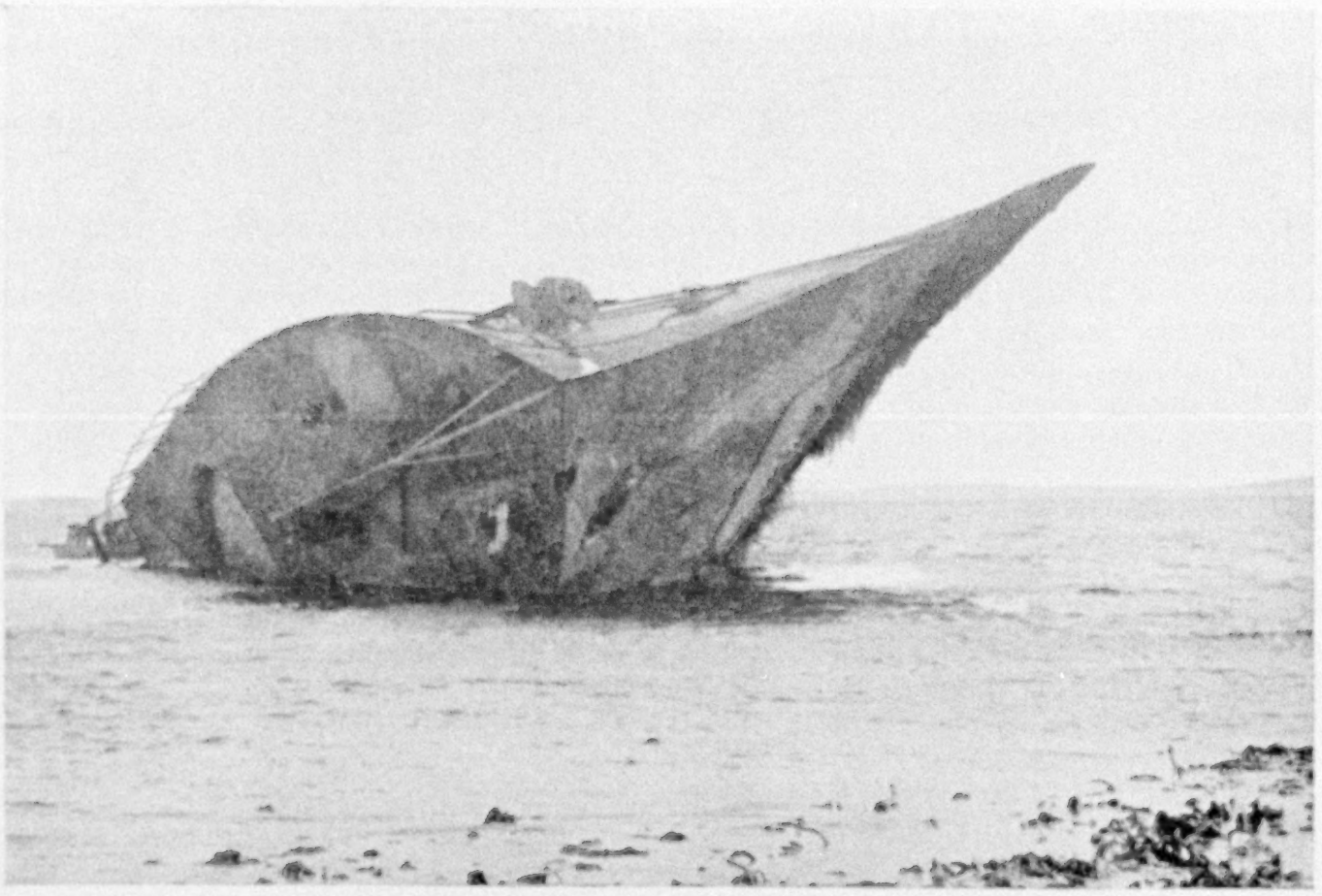
Admiral Strauss returned to the United States to supervise this work, leaving Captain R. C. Bulmer, U. S. N., in command of the mine-sweeping detachment at Inverness, to make the necessary arrangements preliminary to the arrival of the mine-sweepers.

A base for operations had to be selected; fuel and water facilities provided; suitable sweep-gear must be developed, and, if possible, further experiments carried out to gain some definite knowledge of the behavior of the mines.

It was March before the *Patuxent's* rudder had been replaced, and while this was being done both she and the *Patapsco* were equipped with home-made electrical protective devices, so they might cruise in safety through the fields of mines.

Newly developed kites, capable of attaining the great depth at which we were required to sweep, were borrowed from the British Admiralty, together with a few lengths of serrated sweep-wire, so called because of its peculiar lay, which enables it to saw the mooring of a mine, and the *Patapsco* and *Patuxent* set out for the barrage to experiment with this equipment, which was later to be used by the vessels fitting out at home.

The sweep was passed and sounding tubes were slid down to the kites to measure the depths at which they were



ONCE A MIGHTY UNIT OF GERMANY'S PROUD HIGH SEAS FLEET

Kirkwall, the base of the American mine-sweepers, is separated from Scapa Flow by only a narrow neck of land. When it was known that the interned German fleet was being scuttled by the men on board, Admiral Strauss ordered all his fleet then in harbor to proceed at full speed to Scapa, hoping that they might succeed in beaching some of the vessels before they had filled and sunk. But the work of destruction was so complete that our vessels were of no assistance.

flying; then the course was altered to head across the mine field.

The first few explosions were well astern and in the center of the sweep, and although the terrific concussion shook the ships from end to end, the men quickly became used to the novel sensation and apparently enjoyed it. Mines, too, kept popping up behind the sweep, having been cut from their moorings before the sweep-wire could reach the mines and cause them to explode.

A MINE EXPLODES BENEATH THE "PATUXENT"

Then suddenly it seemed as if all bedlam had broken loose. Towering columns of water were belched up on every side! The *Patuxent* seemed to stop for a moment as if stunned, and then, as the spray and water settled back again, great clouds of black smoke, mingled with flame, poured from her funnel.

The lights below decks dimmed and went out; the floor plates in the fire-rooms had been hurled from the decks; an ever-widening circle of brown, discolored water spread out around the ship. The vessel had been countermined.

Luckily, the mine which had exploded below her had been planted at the deepest level, and, aside from minor damages, which could be repaired in a few hours, she had not been injured. A mine fired by the sweep-wire had caused these others to explode sympathetically.

We had sampled a danger with which we were to be faced constantly in the coming months—a danger that no human effort could avert.

Many of the supersensitive mines had exploded prematurely shortly after the barrage was laid, and we had hoped that only those possessing normal stability now were left; but such was not the case. The Electrical Protective Device

THE LITTLE TOWN OF KIRKWALL, SCOTLAND, WITH ITS BARREN, WIND-SWEPT HILLS, HAS PLAYED AN IMPORTANT RÔLE IN AMERICAN NAVAL LIFE DURING THE PAST FIVE YEARS

Hundreds of patrol craft engaged in hunting submarines and in escort work were based here until the Armistice. Four months later the Mine-Sweeping Force made this its base while clearing the North Sea Barrage.

would prevent mines from exploding when in contact with the ship, but against these countermines it was of no avail—and an upper-level countermine beneath sweeper would undoubtedly destroy her.

KIRKWALL, AMERICA'S MINE-SWEEPING BASE IN THE ORKNEYS

The next mine encountered in the sweep exploded, shattering the sweep-wire, and before the break was mended a blinding snow-storm cut short further experiments. The two ships then proceeded to Lerwick, a drowsy little town in the Shetland Islands, and later to Kirkwall, in the Orkneys, choosing the latter place as our base for the coming operations.

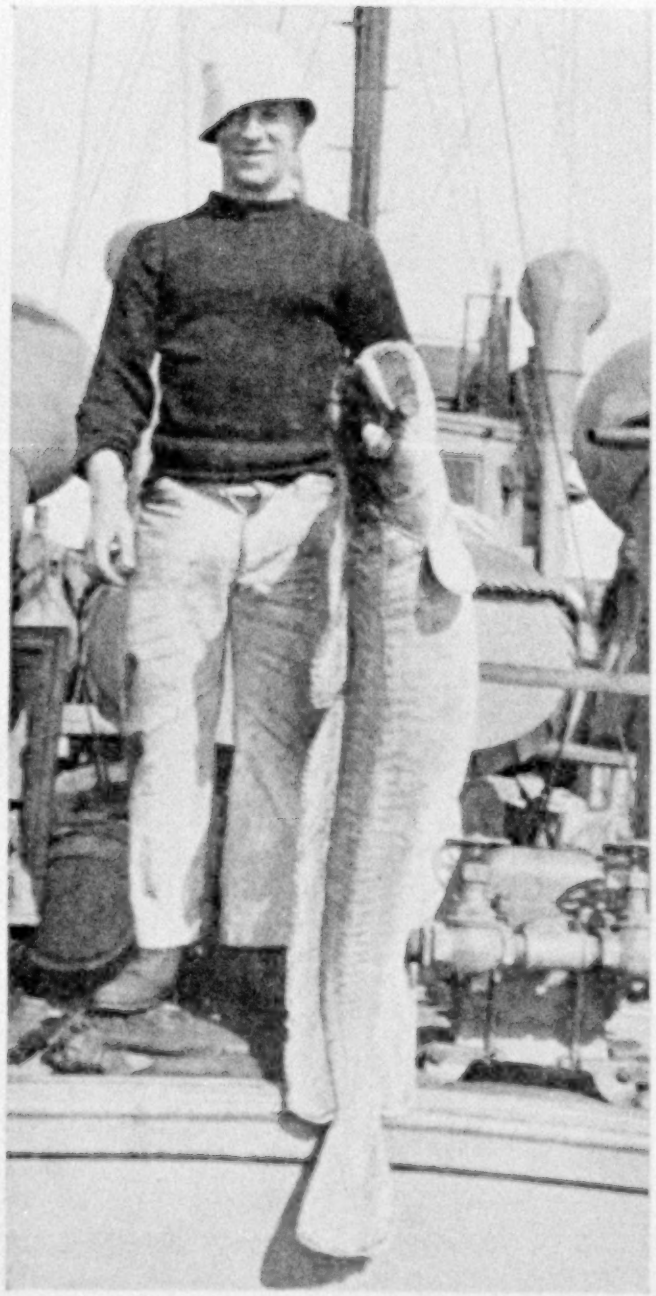
During this experimental trip twenty-five mines were exploded and fourteen were cut adrift. As many of these floating mines as possible were sunk by rifle fire, but it was difficult to find them after they had once been lost to sight. It was evident that special ships would be required to follow up each pair of sweepers and sink the mines as fast as they appeared. The only vessels then available were the little sub-chasers, which had been doing patrol duty in the English Channel, and twenty of them were obtained and sent to Inverness.

By the middle of April all arrangements were completed and we were ready to begin actual sweeping the moment that the mine-sweepers arrived. Oil-ships, colliers, gasoline, and water boats had been borrowed from the British Admiralty; the sub-chasers had been drilled in their new duties; special buoys had been obtained for marking the barrage, and the sweepers were by then halfway across the Atlantic.

THE SWEEPERS ARRIVE FOR THE BIG TASK

On April 20, 1918, the first twelve of these sturdy little vessels arrived in Inverness. What a weird future confronted them!

A veil of mystery surrounded everything, even more than in the silent operations of the war. Those who manned



THOUSANDS AND THOUSANDS OF FISH WERE KILLED BY THE EXPLOSIONS OF THE MINES

The sub-chasers kept the larger ships constantly supplied with cod, pollack, and herring, which are most abundant in the North Sea. Occasionally a curious specimen, such as shown above, was picked up by a vessel.

the sweepers only knew that they had been selected to sweep the hitherto invincible barrage. The ships had suddenly been ordered to the navy yards at Boston and Norfolk, where curious appliances of every description had been placed on board. Workmen invaded the ships and began stringing wires and installing elaborate electrical panels. Some one said these were to keep the mines from exploding when their vessels struck them. Then, too, rumors had reached home that the *Patuxent* had narrowly escaped destruction while experimenting in the barrage.

The day following the arrival of the sweepers Rear-Admiral Strauss returned to Inverness and hoisted his flag on the *Black Hawk*, the flag and repair ship of the force.

Not a moment was to be lost. If humanly possible, the barrage must be cleared away during the year, and that meant by October, for from then on the short days and severe storms would make our efforts futile.

As soon as the necessary overhaul incident to a transatlantic voyage had been completed, the mine force got under way; the sweepers and six chasers headed for the barrage; the *Black Hawk* and other chasers for their new base at Kirkwall.

THE RESULTS OF THE FIRST TRIP

No attempt was to be made on this first operation to clear a definite area of mines. The object was experimental. Several appliances remained to be tested, chiefly an amplification of the Electrical Protective Device whereby the mines would all be exploded by an electrical connection to the sweep-wire; also, we must know more definitely the present condition of the field—what percentage of the mines remained, and were they still in the positions in which originally planted, or had the storms and currents scattered them about.

At the end of two days the ships returned to port, having accounted for 221 mines—less than half of 1 per cent of the total number we had laid. The electrical scheme for exploding the mines was not successful, and, even worse, it had a most alarming effect on the magnetic compasses. The powerful solenoids caused by the current in the insulated sweep-wire wound around the drums had made the compasses point as much as ninety degrees from the magnetic meridian; and the navigators found their ships actually going east or west when they were thought to be headed north.

The mines, as far as could be told, were still in place and had not dragged from their original positions.

None of the ships had been damaged, although numerous instances of countermining had occurred.

From the results of these first two days it was obvious that at the present rate of sweeping it would be impossible to complete the work within the year; so Admiral Strauss cabled a request to Washington that sixteen additional sweepers be fitted out and dispatched as expeditiously as possible. He also made arrangements to charter from the British Admiralty twenty newly built steam trawlers and man them with our own crews, these vessels being required as marker boats to enable the sweepers to maintain their positions while maneuvering upon the field.

A BARRIER 260 FEET DEEP IMPENETRABLE FOR SUBMARINES

By the 10th of May the sweepers were ready to go out again. This time a definite area was to be cleared.

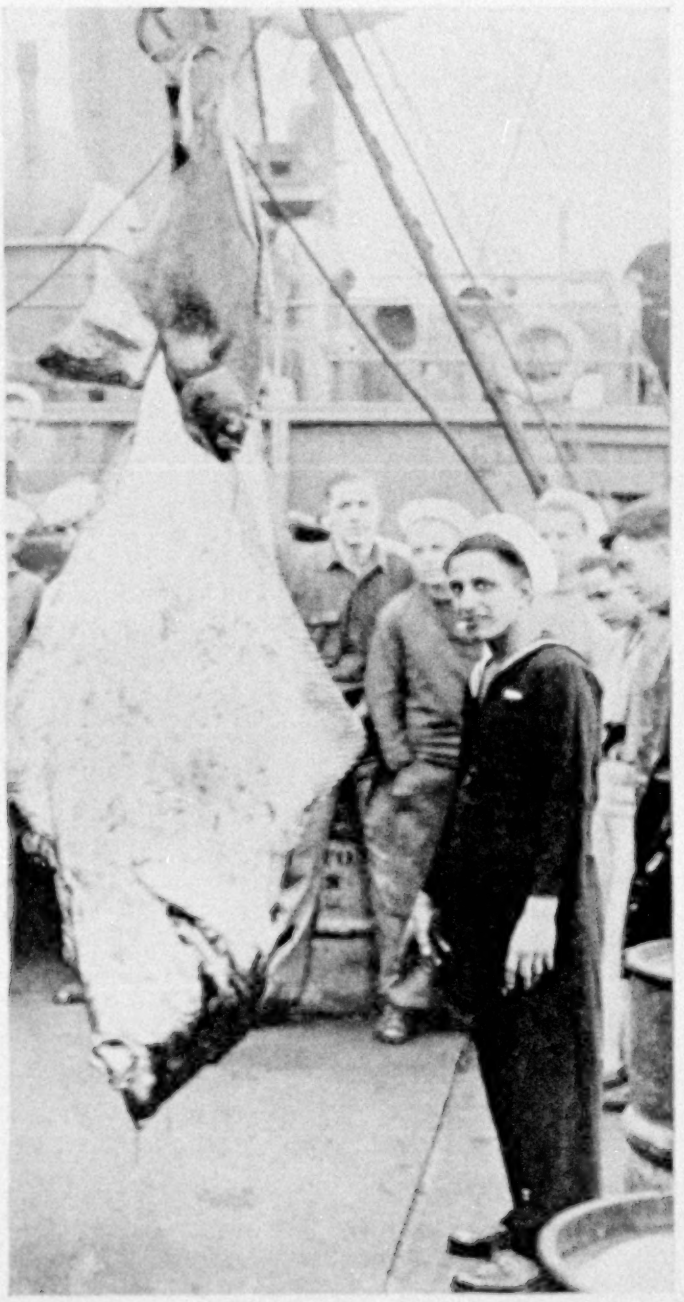
The barrage was composed of thirteen separate groups of American mines. Each group consisted of from two to six parallel rows of mines, and the mines in each row were laid at one of three levels—upper, middle, or lower—the three forming a complete barrier in a vertical plane to a depth of 260 feet.

The average group contained five rows, and of these three were laid at the upper level to give the surface barrage the greatest density. The reason was psychological: Submarines, knowing the barrage was there, would prefer to risk crossing on the surface, even if they knew their chances were less.

The upper-level mines were now our gravest concern, for the damage done a sweeper by the explosion of one of these would, of course, be far more serious than from a lower-level mine.

Group 12 (see chart, page 105) was selected to be cleared on this coming operation, since it consisted of only three rows of mines, only one of which was laid at the upper level.

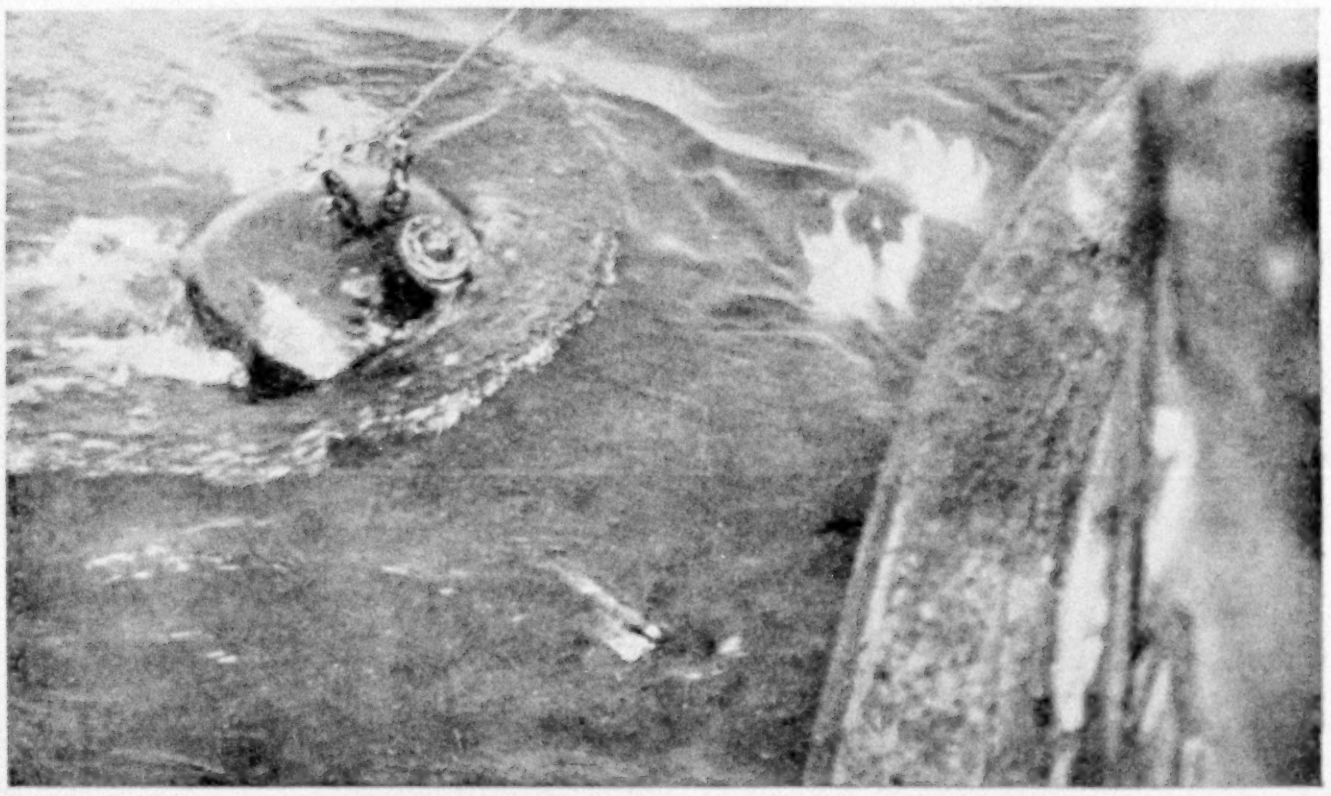
With the danger from countermining reduced to the minimum, the experience gained in sweeping this group might provide a further means of safeguarding the ships before the more dangerous groups were undertaken.



A GIANT HALIBUT, WEIGHING MORE THAN 400 POUNDS, CAUGHT NEAR THE ORKNEY ISLANDS

In order to reduce the possible effects of countermining still further, each pair of sweepers was to work independently of the others, so that all pairs should be evenly spaced along the length of the field. Then, if an exploding mine should cause others in its vicinity to countermine, the possibility of damaging other sweepers than the one pair was very remote.

The method of sweeping to be used was what is called transverse sweeping—that is, the sweepers were to cross the lines of mines perpendicular to their direction, then turn, recross, and so on. This method is much more laborious than attempting to keep a line of mines be-



A MINE FOUL OF THE "PATUXENT'S" KITE

In less than a minute after the picture was taken the mine exploded, blowing several men overboard and slightly injuring the commanding officer. Most of the force of the explosion was expended in the air, however, and the damage to the ship was not extensive (see text on this page).

tween the pair of sweepers and steaming longitudinally down its length (longitudinal sweeping), but was deemed to be safer, since the possibility of being above a mine when it exploded was considered less.

THE CASUALTIES BEGIN

No sooner had the sweepers reached the field than the casualties began, and, curiously, the cause was from an entirely unexpected source. From now on this same thing happened so frequently that it seemed almost incredible that it had not occurred before.

The *Patuxent* was the first victim. Her sweep had been severed by the explosion of a mine and had to be hauled on board to be repaired. By the time the kite was within sight (it can be seen only a few feet below the surface), a mine could be seen floating near it. Evidently its mooring had fouled the kite and it was necessary, of course, to clear it before the kite could be lifted.

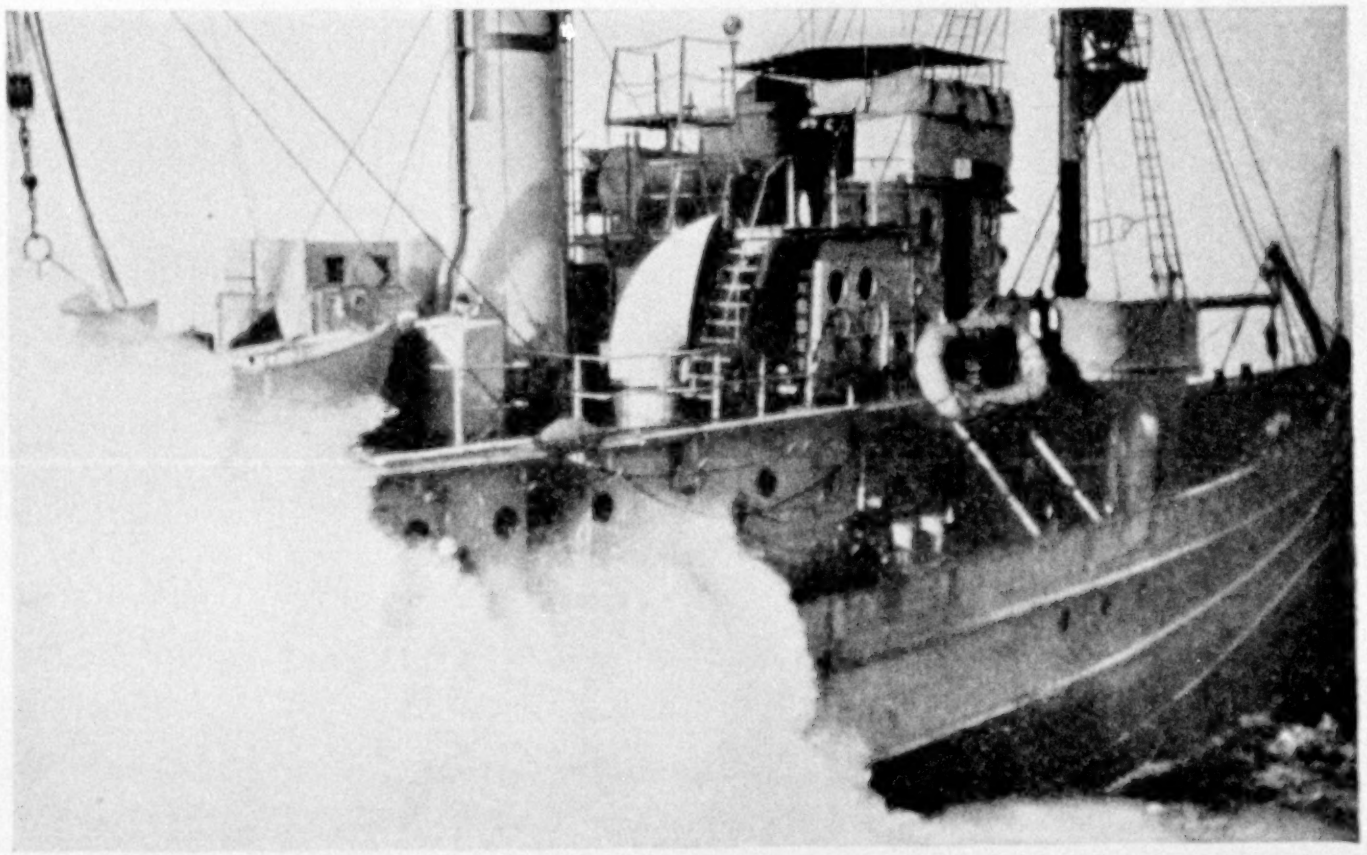
The commanding officer, realizing the danger, sent all hands forward and went aft himself to do the work, assisted by one man.

The mine was within four or five feet of the ship's side when, suddenly, without warning or apparent cause, it exploded.

For an instant the entire ship was obscured in the mass of flying spray, and when it had subsided four of the crew could be seen struggling in the water. Fortunately, all of them were rescued by their comrades. The captain was, perhaps, the luckiest of all; standing only a few feet from the mine when it had detonated, the only injury he sustained was the loss of his right thumb, which had been amputated by a flying fragment.

Since the mine was not submerged, the force of the explosion was largely spent in the air, and consequently the damage to the ship was not serious. A few days in dry-dock were sufficient to repair her.

Up to the time of this accident, when mines were found foul of the kites or the sweep they had been regarded more or less as curios. Many had been hauled on board; for, according to design, they were supposed to be quite safe when on the surface. Now no one trusted them. One



A CURIOUS EXPLOSION

While a sweeper was going alongside her mate to pass the sweep, a mine, from some unknown cause, exploded between them. The entire after part of this vessel was drenched, but the damage, fortunately, was not serious.

ship which at the time had a mine on board even went so far as to double the risk by throwing it back into the sea.

Infinite care, however, could not entirely eliminate this particular danger. In the first place, the mine could never be seen until it was dangerously close to the ship; then the course of action that was chosen might or might not prove the proper one.

A TRAGIC MISHAP

Two days after the *Patuxent* was damaged an identical casualty befell the *Bobolink*, but with far more serious consequences. The captain, as in the *Patuxent's* case, went aft to clear the mine himself, sending all hands forward to a place of safety except those actually required to assist him.

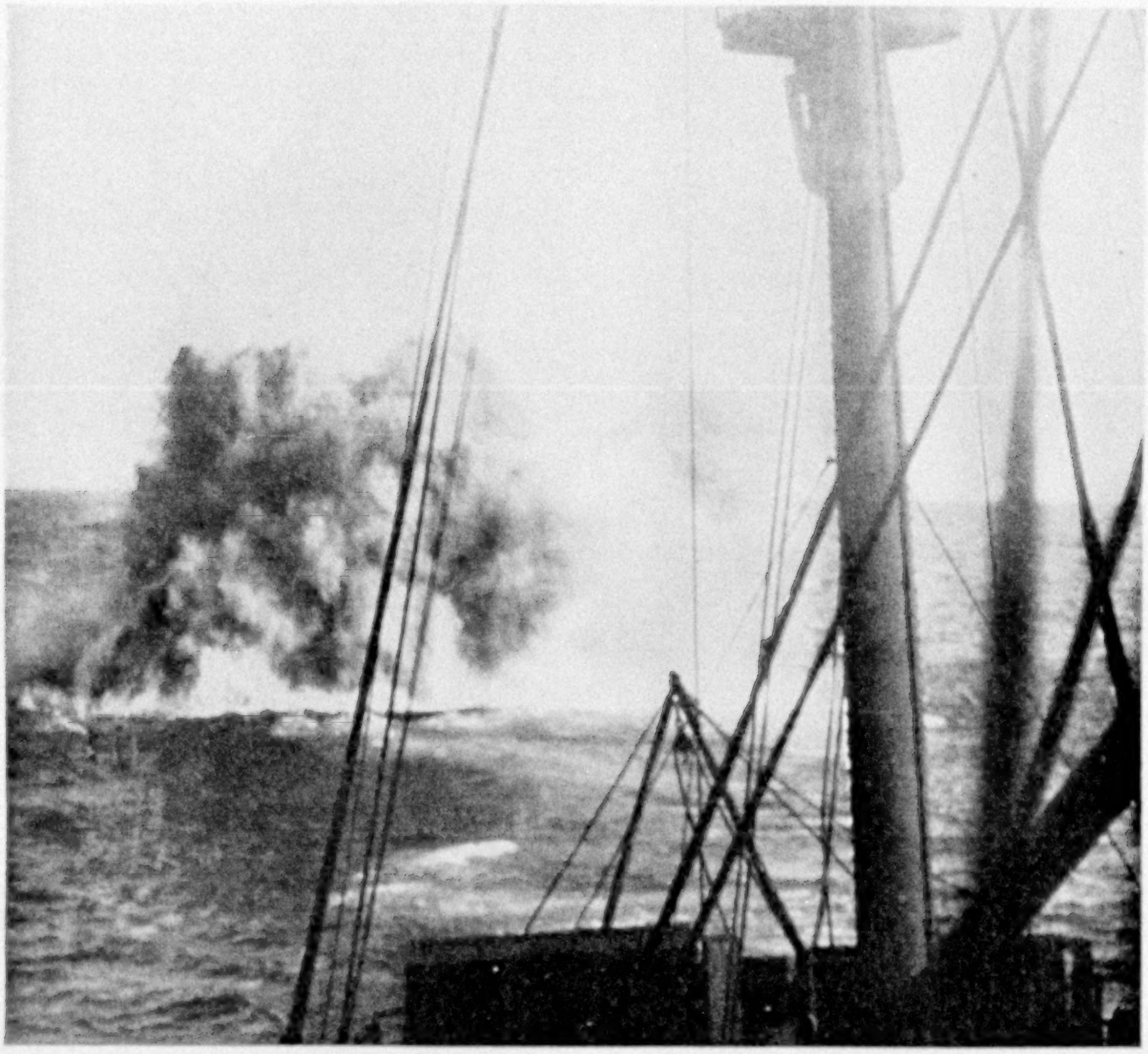
The towing engine had been stopped as soon as the mine was sighted, leaving it somewhat submerged. It exploded before anything could be done to clear it.

The commanding officer, Lieutenant Frank Bruce, U. S. N., was killed. The first lieutenant and several men were blown into the water, the first lieutenant falling 100 feet from the ship. The men who plunged in after them succeeded in saving all, even though the first lieutenant had been rendered unconscious by the fall.

The *Bobolink* was critically damaged by the explosion. The entire after body had been distorted, parts of the plating being driven in two to three feet by the concussion. The rudder was gone, the engine disabled, and the ship was leaking badly. Her boilers, which are well forward, were not injured and enabled the powerful wrecking pumps to take care of the water.

Two other sweepers towed the damaged vessel to Scapa Flow, near Kirkwall, where she was docked and temporary repairs made. Later she was towed to Devonport, where she still remained in dock when the Mine Force sailed for home, five months later.

Seventeen days after the operation began, Group 12 was completed and the vessels returned to port. Several other accidents had happened, two of which



DUE TO AN ELECTRICAL PROTECTIVE DEVICE, THE "LAPWING" SUCCEEDED IN PASSING SAFELY OVER THIS MINE, WHICH EXPLODED AS SOON AS IT WAS OUTSIDE THE RADIUS OF IMMUNITY ESTABLISHED BY THAT REMARKABLE CONTRIVANCE

Aside from shaking the vessel severely and breaking such articles as chinaware and lamp globes, no damage was ordinarily incurred by an explosion so far astern.

necessitated docking the sweepers to stop the leaks caused by explosions.

The rate of sweeping had been far below our expectations, but we were learning.

VAST QUANTITIES OF SWEEPING GEAR BLOWN AWAY

The most serious factor, aside from the loss of life, was the expenditure of sweeping gear. Thousands upon thousands of fathoms of serrated sweep-wire, together with more than fifty plunger kites, had been blown away by the exploding mines. Our original estimates had not anticipated so large a loss for the entire barrage as had been expended by this single operation. Moreover, both of these articles were exceedingly difficult to obtain.

Our present rate of work was far too slow to complete the barrage within the year, and even the thought of the idle winter days in that miserable climate, while we waited again for spring weather to resume operations, was most disheartening.

WORKING EIGHTEEN HOURS A DAY

Every minute on the mine fields was being utilized. In that high latitude, where the summer days are so unusually

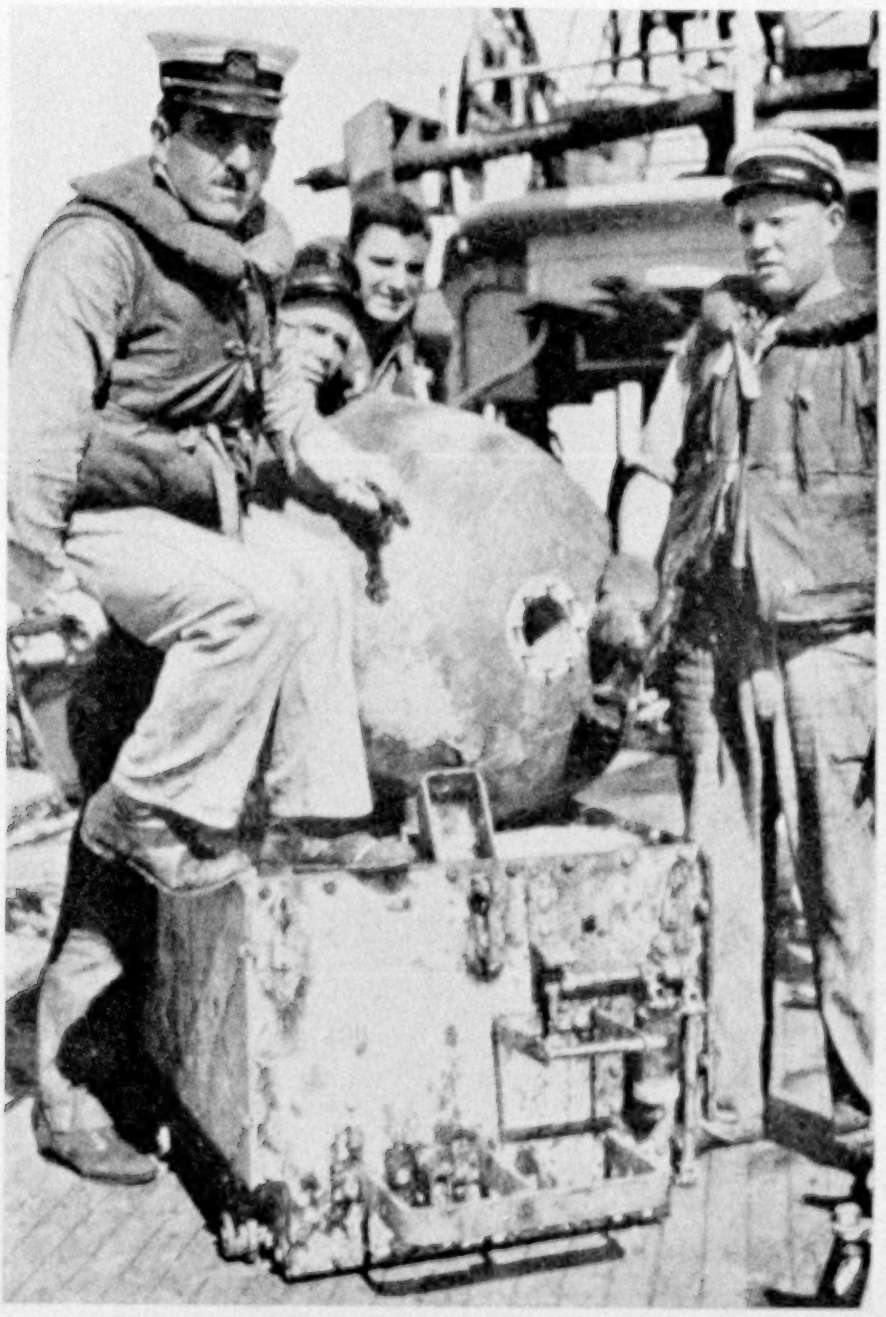
long, the sweepers worked from four in the morning until ten, and sometimes even later, at night.

The days in port were equally busy. Fuel, water, provisions, and new sweep gear had to be obtained; boilers had to be cleaned and many repairs were always required. The machine-shops on the two repair-ships buzzed incessantly, and as soon as everything could be finished the ships were under way once more for the barrage.

Group 9, the largest group of mines that has ever been laid, was selected for the next operation.

Five thousand five hundred and twenty mines had been laid within its boundaries. The same method of sweeping was to be used as on the previous operation, except that the three pairs of sweepers were to work together, sweeping their section of the field longitudinally instead of transversely. It was a bold experiment, but if they could demonstrate that the danger was no greater than in the other form of sweeping (this largely depended on their ability to keep between the invisible lines of mines), then there might yet be a possibility of finishing the task before winter.

Admiral Strauss spent several days on one of these sweepers in order personally to judge the relative merits of the two methods.



A MINE WITH ITS ANCHOR, WHICH FOULED THE SWEEP AND WAS HAULED ON BOARD

This extremely dangerous practice was automatically discontinued after the *Bobolink's* disaster (see page 117).

A SUBMARINE WRECK CAUGHT IN THE SWEEP-WIRE

An interesting indication of the success of the barrage was encountered while sweeping in the central portion of this group. The *Heron* and *Sanderling*, while crossing the lines of mines, were suddenly brought almost to a standstill; then their sweep-wire snapped. A few minutes later a huge patch of oil rose to the surface and spread out astern of them. The sweep had fouled the wreck of a submarine which had been sunk in the barrage. Curiously, the mining squadron, when passing close to this same spot a few days after they had laid the field, sighted the dead body of a German sailor floating in the water.

From the records of the Admiralty the wreck was presumed to be the U. B. 127.

The sweeping progressed slowly. The weather, although it was now June, was almost as violent as it had been during

TO INCREASE THE SPEED OF SWEEPING, EACH LINE OF MINES WAS MARKED BY BUOYS PRELIMINARY TO THE SWEEPING OPERATION

The picture shows a pair of sweepers crossing a line of upper level mines, three of which have been exploded by the sweep wire. The buoy-laying ship (from which the picture was taken) is following the pair of sweepers across the field to plant a buoy when 500 yards from the line of mines as indicated by the explosions.

the winter months. Not until 27 days after the operation had begun was the group finally completed. Some improvement had been made. No ships had been seriously damaged, although many minor accidents had happened.

There was some consolation that our rate of sweeping was slightly better than that of the two British detachments engaged in clearing their portions of the barrage; but it was far from satisfactory; the rate had to be *tripled* if we were to finish in 1919!

THE CHIEF CAUSES FOR SLOW PROGRESS

The principal losses of time were due to the frequency that sweeps parted, with the consequent delay in repairing them, and to the difficulty in navigating with sufficient accuracy to insure that every square foot of the field had been covered. This latter difficulty necessitated sweeping the same area over and over again to make sure no mines were left.

The first cause offered little room for improvement; with practice, the sweeper crews became more dexterous in mending sweeps and repassing them, but the explosions which parted the wires could not be avoided.

The second cause of loss of time presented many possibilities for improvement: First, by placing all the vessels in formation, so that all the ground could be definitely covered; then have them steam longitudinally down the field. The experiment made by the three pairs of sweepers on the previous operation showed that this was practical; they had suffered no greater losses than the other sweepers, and, although their rate of sweeping was no faster than the others, it was plainly due to the difficulty of telling where they were.

The second possibility for improvement lay in defining accurately each row of mines with suitable buoys before the sweepers were sent out. Some doubt existed if such a thing were possible, for it had appeared in previous sweeping that the mines exploded or rose to the surface in such apparent disorder that to place marker buoys in exact positions relative to the individual rows of mines was almost out of the question. But we at least could try.

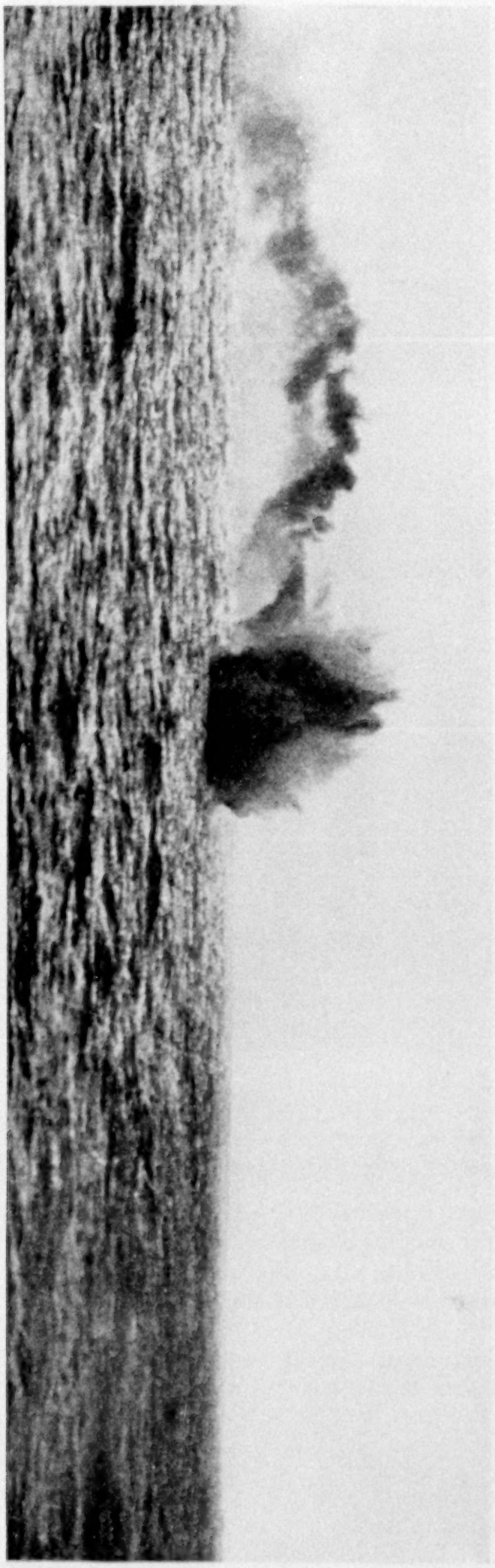
The Admiral directed that a Buoy-laying Squadron should be fitted out at once, in order to have the new fields marked by the time the overhaul and refit of the sweepers was completed.

THE BUOY-LAYING SQUADRON BEGINS WORK

Since the Buoy-laying Squadron automatically took over the duties which the trawlers had, in a lesser way, been performing, it was decided to fit out ten of these vessels for sweeping (they had been built expressly for that purpose by the Admiralty), using them astern of the regular sweepers to catch any mines which might have escaped the initial sweep. This would give a large, compact formation, with sufficient breadth to cover the entire width of the group.

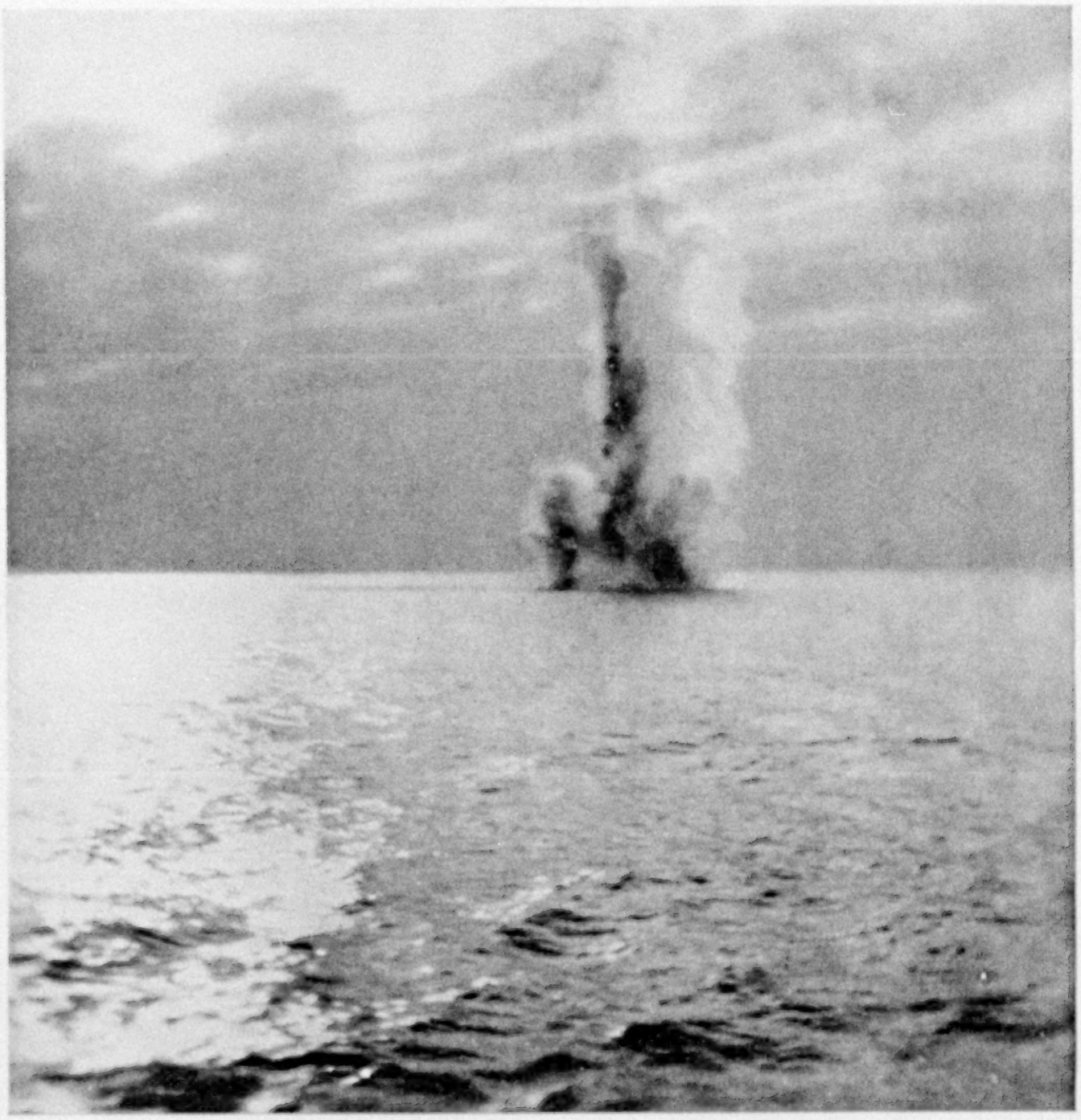
In order to reduce as much as possible the loss of time due to parted sweeps, three pairs of sweepers were to steam in column along each row of mines; then, when the sweep of the leading pair was broken, they should drop out of formation, repass, and take position as the last pair. In this manner it was hoped that the sweepers as a unit might sweep continuously the full length of the field, keeping at least one pair in action on each line of mines, so as not to lose track of its position.

Five days after the ships re-



WHILE HAULING IN HER SWEEP, THE "BOBOLINK" SIGHTED A MINE ENTANGLED WITH THE KITE

Before it could be cleared, the mine exploded, killing the captain and blowing several men from the ship into the water. The smoke of the *Bobolink* can be seen emerging from the explosion (see page 117).



A COUNTERMINE (SEE PAGE 112)

When least expected, the sea, with a mighty roar, would oftentimes belch up a pillar of white, shattered water. The cause of countermining could never be determined. Occurring always when least expected, this was a constant source of danger to the vessels in the field.

turned to port they were under way again for the mine field. Not much rest after 27 days at sea, where Sundays and holidays were omitted from the calendars.

The buoying of the little Group 12A had been successfully completed, and seven hours and forty minutes after the sweepers began not a single mine remained.

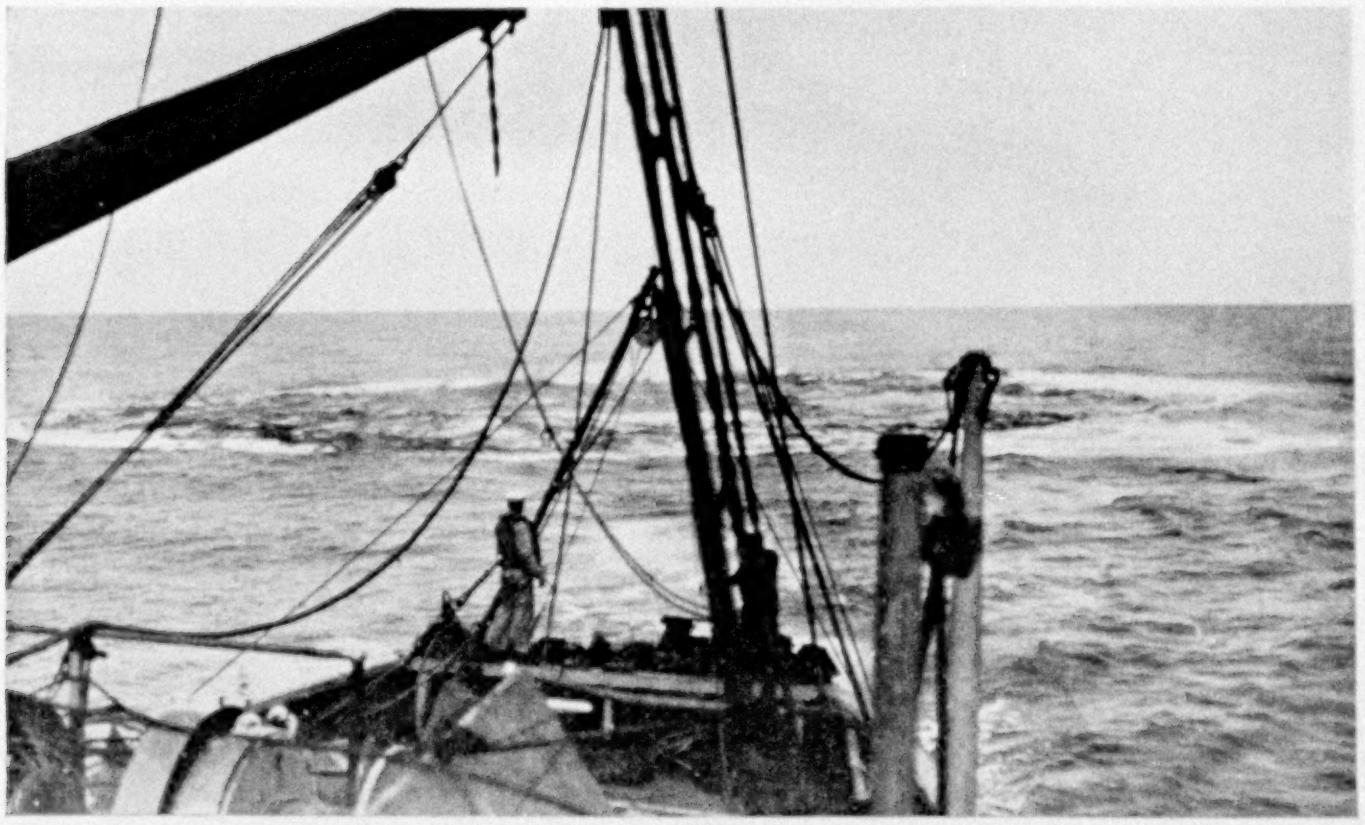
It seemed incredible, impossible, that this could be true! Ordinarily it would have taken us five times that long.

Here indeed was real cause for jubilation. The enthusiasm of the force was unbounded, and for the first time it became possible to foresee the end of our task.

AN IMPRESSIVE SIGHT

By this time the buoying of the large Group 11 was far enough advanced for the sweeping to begin immediately.

On they came, 24 sweepers, 10 trawlers, and an equal number of the little sub-chasers.



EXPLOSION OF A DEEP-LEVEL MINE

Due to the tremendous pressure of the water on top of the mines which were planted at the lowest level, the force of the explosion was not sufficient to throw the water high into the air, as is done by the upper-level mines. The shock of the explosion was felt immediately. The "slick" did not appear until approximately thirty seconds later.

It was an impressive sight to see that armada, formed for sweeping, standing up the mine field, the air reverberating with the continuous roar of the exploding mines, and simultaneously the glistening pillars of white water springing up behind the sweepers, poising for an instant, and then disappearing.

Still farther astern the fainter plop-plop of the rifles and machine-guns could be heard, as the chasers filled the floating mines with holes.

A SHORT-LIVED TRIUMPH

The triumph of the day was contagious. No casualties had occurred to mar the inauguration of this new method of sweeping, and it began to look as if the solution of our difficulties had been accomplished.

But the morrow held in store a flood of catastrophes of every kind—the worst day we should have to face during the entire operations.

The first victim was the *Curlew*, which was crippled by the explosion of a mine fouled in her kite and was forced to return to Kirkwall for repairs. A few minutes later three mines were countermined beneath the *Patapsco;* but fortunately the damage was not serious.

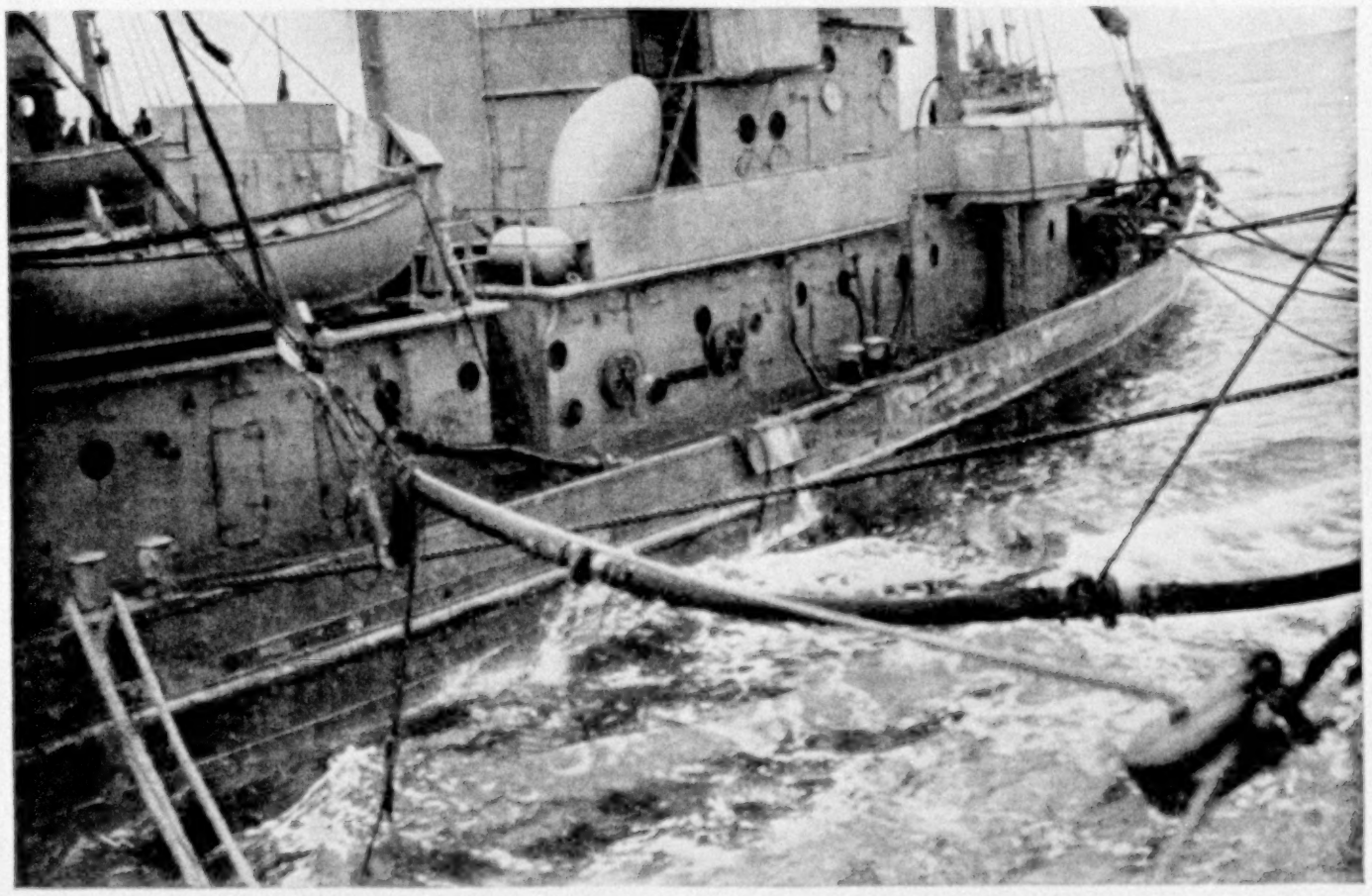
The *Penguin* followed, with numerous minor damages from a mine foul of her kite, and the same thing befell the *William Darnold* almost at the same time. Both ships were able to make temporary repairs on the field and continued operations.

The *Lapwing* was next. She was seriously countermined and had to return to port.

Sub-chaser 46 exploded a mine while sinking it, and was injured so badly she could not remain at sea.

A BATTLE WITH THE ELEMENTS

As if such havoc were not sufficient for a single day, six upper-level mines were countermined beneath or close aboard the *Pelican*. When the mass of water had subsided and the vessel could again be seen, she was sinking. Then began one of the most remarkable strug-



SAVING THE "PELICAN"

Seventeen minutes after the hull of the *Pelican* had been shattered by a series of successive countermines, the *Auk* on one side and the *Eider* on the other had made fast and, with their wrecking hoses spanning the intervals between them, were pumping to their maximum capacity to keep the vessel, whose high bow was then but two feet above the water, afloat until they could reach port.

gles of will power against the elements ever recorded.

Seventeen minutes after the explosions, Captain Bulmer, who had gone out to direct personally the sweeping operation, had placed his flagship, the *Auk*, alongside the *Pelican*, and her powerful wrecking pumps were throbbing to their full capacity to keep the riddled ship afloat. A few moments later the *Eider* had made fast on the other side, and her pumps were doing likewise. The *Teal* then passed her towline to the *Pelican*, and the four vessels, lashed together, headed slowly for port.

At that time the weather was good, and the *Auk* and *Eider* were able to keep the *Pelican* fairly well afloat; but when they were still 50 miles from land a head sea began to rise and the situation grew rapidly worse.

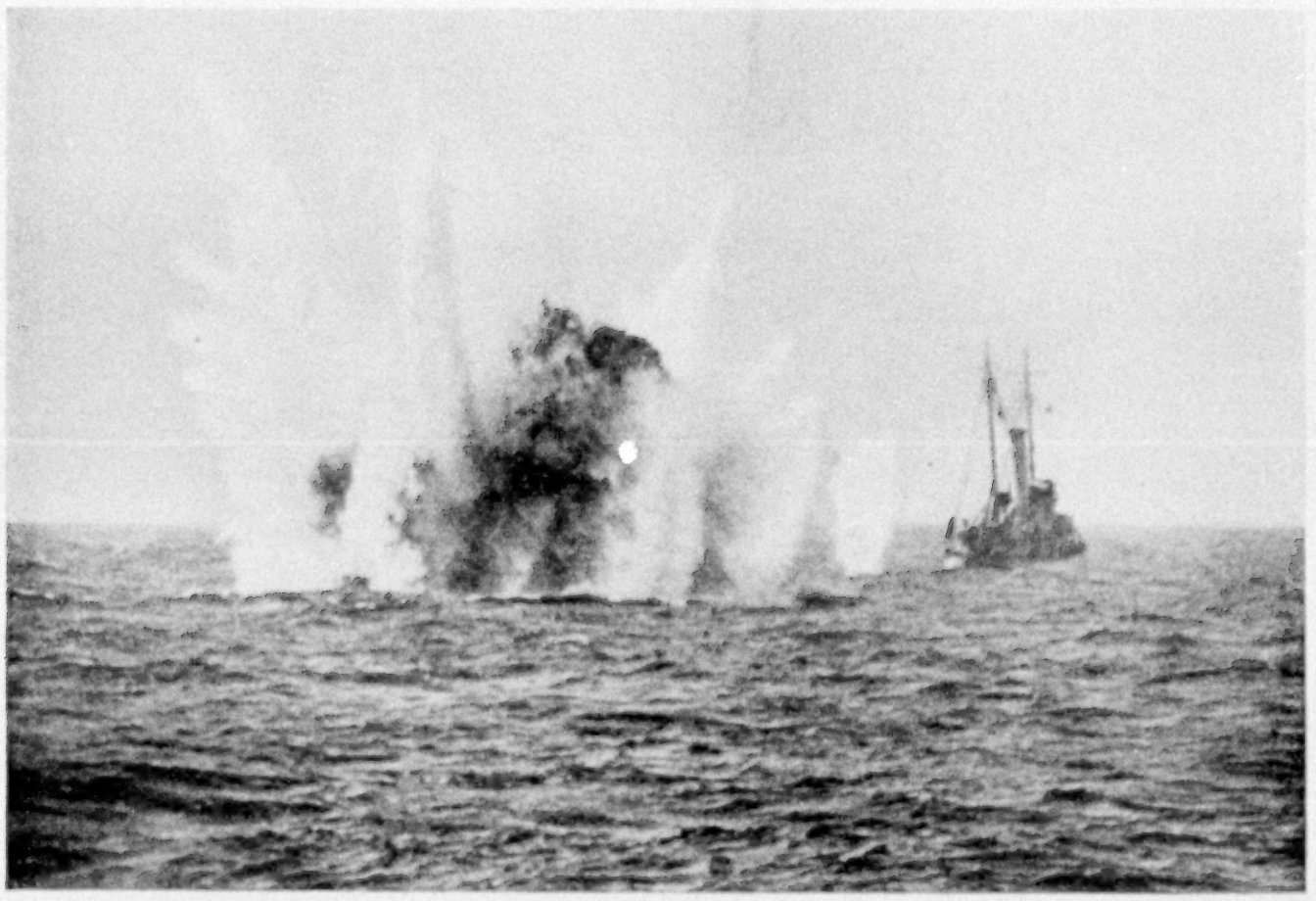
As the vessels were tossed about by the sea, the pump-lines parted, and before they could be repaired the water had gained until the *Pelican's* bow was practically submerged, while her stern projected high above the water. To add to the difficulties, nightfall had overtaken them.

The *Pelican* sank lower and lower; her forward fire-room bulkhead, which alone kept her afloat, was buckled and distorted by the pressure of the water on the forward side. As the water crept higher and higher, the bulkhead was expected to burst at any moment. The crews on the *Auk* and *Eider* worked desperately to get the pumps started again.

Since the vessel was in danger of sinking at any moment, it was unwise to keep unnecessary men aboard; so Captain Bulmer asked for twelve volunteers to remain to do the necessary work.

Every man stepped forward!

The twelve strongest were chosen and the rest had to be ordered off their ship against their will. It was a sight that dimmed the eyes, to see these twelve men,



THE EXPLOSION OF AN UPPER-LEVEL MINE ASTERN OF THE "PATAPSCO"

The darker central portion of the upheaval which rises after the first white spouts of water break the surface is discolored by the gases of the TNT.

when nothing further could be done, grouped together on the stern, high out of water, singing old-fashioned melodies throughout the night.

Then at last, after nineteen hours of struggling, this cortege of ships succeeded in reaching the sheltered waters of Tresness Bay with the *Pelican* still afloat. The dogged determination and skillful seamanship of Captain Bulmer alone had saved her.

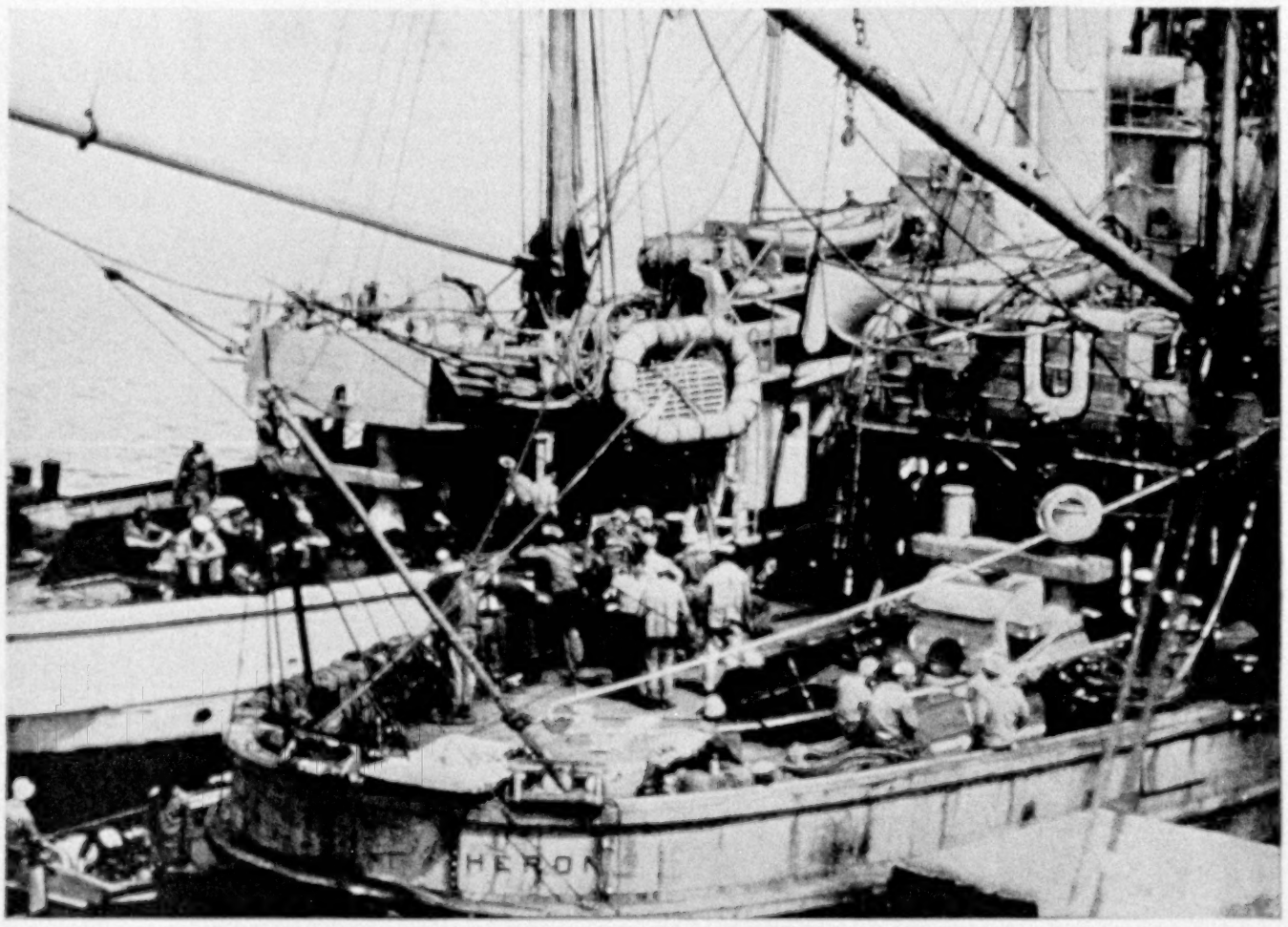
Such holes as could be stopped were plugged, and the following day the ships proceeded to Scapa Flow, where the *Pelican* was docked and sufficiently patched to permit her being towed to Newcastle-on-Tyne, where extensive repairs were undertaken.

The morning following the *Pelican* accident a curious mishap befell the *Flamingo*. After the day's sweeping was completed the vessels used to anchor near the mine fields in order that all hands might get as much rest as was possible in the few short hours of darkness. The deep water and the soft bottom of the open sea do not, however, make an ideal harbor, and on this occasion the *Flamingo* found herself at daybreak several miles south of the spot where she had anchored the night before. While weighing her anchor, which was secured to the end of her sweep-wire, her stern was virtually lifted from the water by the shock of an exploding mine. She had dragged during the night until she was in another group of mines. The damage done by the explosion necessitated docking before she could resume her operations.

AN OFFICER AND SIX MEN SINK WITH THE "BULKELEY"

On the 12th of July, two days after the *Flamingo* was damaged, our most serious accident occurred. Again it was due to a mine fouling a kite. Before the trawler *Richard Bulkeley* could take any steps to remedy the situation, the mine exploded and her hull collapsed under the terrific concussion.

Within seven minutes the vessel had gone down. The other vessels in the



THE FEW DAYS IN PORT BETWEEN THE SWEEPING OPERATIONS WERE EQUALLY AS BUSY AS THE DAYS AT SEA

Besides fueling, watering, and filling up again with stores, the sweeping gear had to be overhauled and repaired, the boilers cleaned, and as many of the leaks stopped as was possible without docking the ship.

vicinity had cut their sweeps, rushed to her assistance, and succeeded in rescuing all except one officer and six men.

AN INSPIRING ACT OF HEROISM

A moment or two before the *Bulkeley* had disappeared from sight, one of those inspiring deeds occurred which live forever in our memories and glorify the noblest traditions of the service. A man, dazed by the shock of the explosion, struggled to the deck. Seeing that he had no life-belt, Commander Frank R. King, U. S. N., took off his own, and, quickly buckling it about the man, helped him to get clear of the ship before she took her final plunge. A moment later the *Bulkeley* had disappeared, carrying down with her, in the vortex of swirling water, this gallant officer, who gave his life that another might live. (To perpetuate his memory, the Secretary of the Navy, a few months later, named a new destroyer in honor of Commander King.)

The remainder of the operation was completed without further serious accident.

From a standpoint of time, the results had been splendid; our rate of sweeping had actually been tripled. On the other hand, the casualties had been enormous—one ship sunk, one permanently disabled, three damaged so badly that docking was necessary, three forced to return to port for repairs, while three had been able to complete repairs on the mine field.

A careful review of the accidents, however, showed that the majority had been due to causes independent of the method of sweeping, and the rapidity with which they had occurred had been proportional to the number of mines destroyed per day; so, evidently the ultimate losses would be equal, and the preference lay decidedly with the more rapid method.

One thing, however, was apparent; it was not safe to sweep with trawlers. Although the British had successfully used

A FLOTILLA OF SUB-CHASERS AT REST

When these small but active war craft were in port they tied up alongside the repair ships in order to facilitate repairs, replenish their stores, and to give their crews as much relaxation as possible.

them for years, their structural strength was far too light to withstand the explosions of the American-made mines. Arrangements were therefore made to return thirteen of these vessels to the Admiralty, six being retained for transporting gear and supplies from Inverness to Kirkwall and for the delivery of sweeping material to the vessels on the mine field.

The new sweepers which the Admiral had requested in May now began to arrive, fortunately just in time to replace the vacancies caused by turning back the trawlers and the absence of the ships which had been crippled by explosions. Eight had reached Kirkwall within the week, so that now the total force consisted of 32 sweepers, 24 sub-chasers, and 6 trawlers, besides the two repair ships.

SWEEPERS SET NEW RECORDS

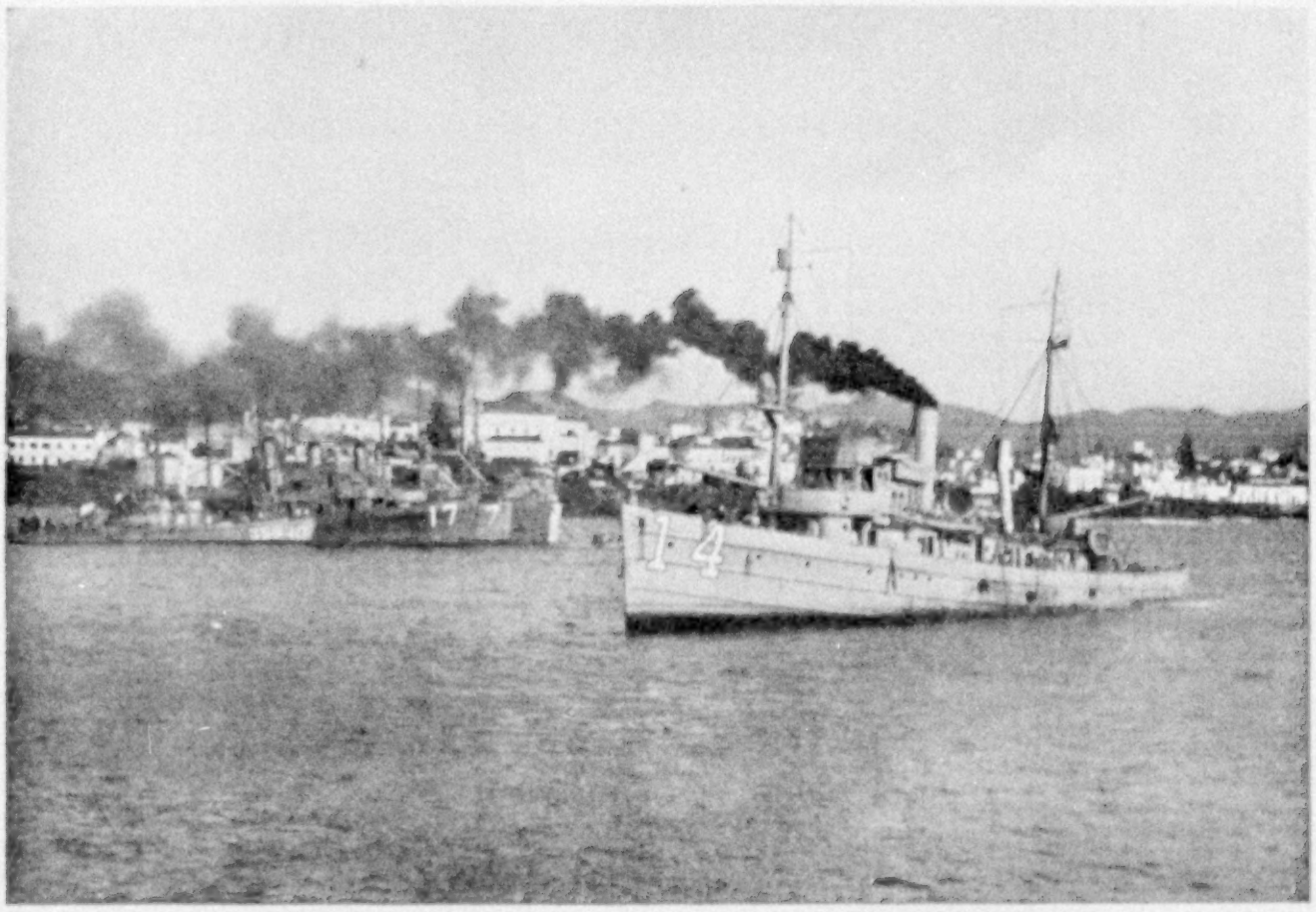
When all the vessels were in port the little harbor of Kirkwall bristled with activities, resembling more the busy harbor of New York than that isolated little village bordering on the Frigid Zone.

After five days in port the sweepers headed once more for the mine fields. The two groups designated to be cleared were finished in such record-breaking time that the sweepers asked permission to try to do two more before going back to port.

The Buoy-laying Squadron was rushed out to mark the new fields, but were no longer able to keep ahead of the sweepers, and another pair of vessels had to be added to their force.

At the end of sixteen days Groups 3, 5, 6, and 7 were all swept. The casualties had been remarkably light. Fifty-five per cent of the barrage was now cleared, and although it was the middle of August, with the best part of the summer gone and the days rapidly growing shorter, every officer and man was determined he would not give up until the last mine in the North Sea had been destroyed.

Of the remaining six groups, five were



WHILE CLEARING THE MINES BORDERING THE NORWEGIAN COAST THE SWEEPERS PUT INTO STAVANGER

This is a bustling little town, made prosperous by the war. The American mine-sweepers came here to obtain fresh water and redistribute their sweep-gear.

at the extreme eastern side of the barrage. The other, Group 8, began just off the entrance to Kirkwall, but could not be undertaken until the British had removed their line of mines, laid closely parallel to ours; for theirs, which were only six feet below the surface, were more dangerous to us than ours to them, and consequently should be undertaken first.

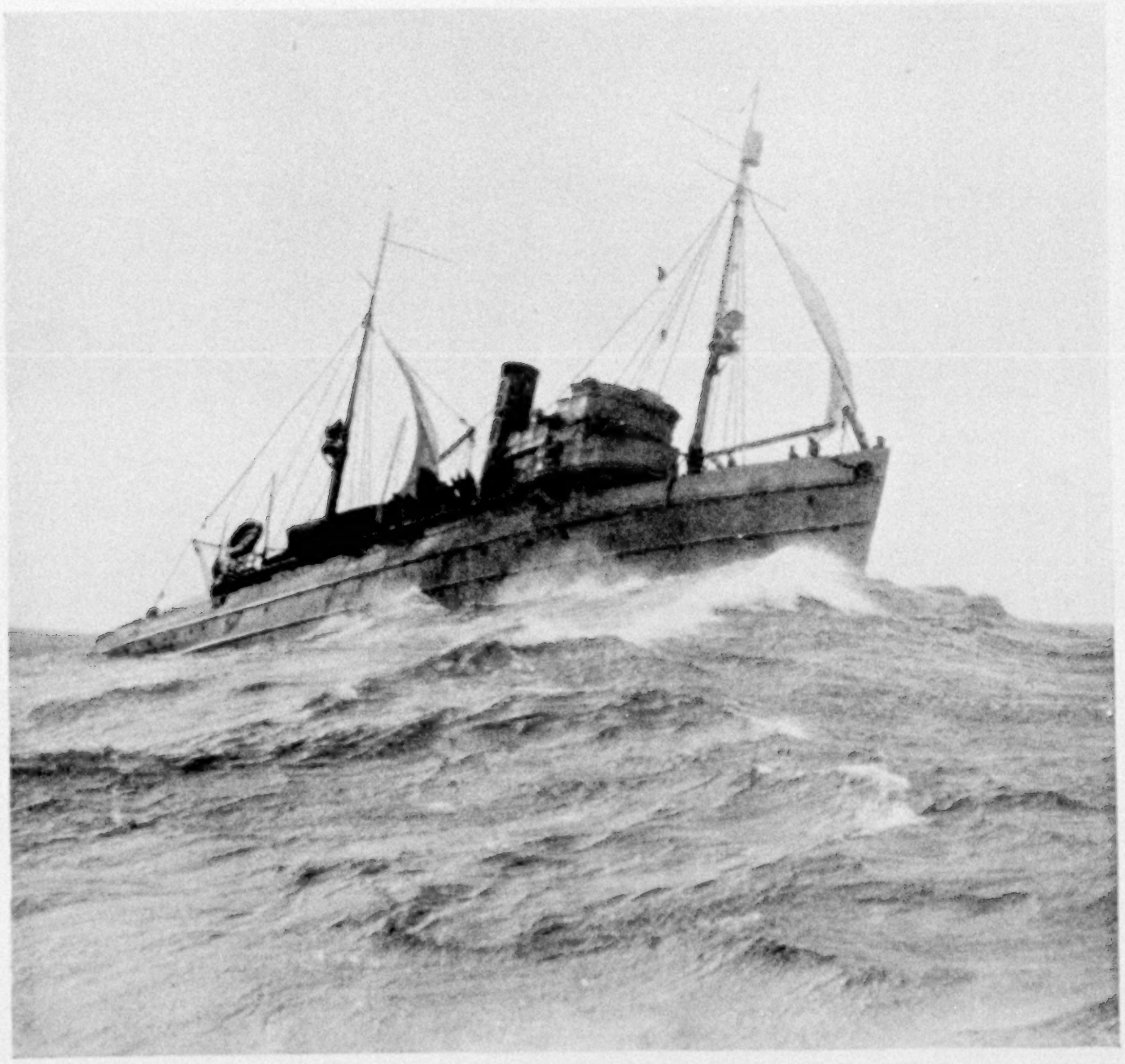
Four days sufficed this time for repairs and overhaul in port. To a man aboard a sweeper it seemed as if he lived continuously at sea; and for such small ships, too, it was indeed an enviable endurance record they were making.

Even the routine affairs of administration, which almost invariably take place in port, had to be conducted on the mine field. An interesting example of this occurred when the annual examination of enlisted men for promotion to warrant officers fell due.

A storm was raging at the time, making it impossible to sweep and equally impossible to transfer the candidates from their various vessels in order that they might appear before the examining board on the flagship; so that most valuable invention, the radio-telephone, was resorted to, and by this means each candidate was simultaneously asked the successive questions of the examination while he sat at a desk on his own ship.

A SHORTAGE OF KITES THREATENS THE WORK

Aside from the delays caused by the gales, which now came on in greater violence and frequency, the sweeping progressed without interruption or serious casualty. The speed at which we now were working, however, introduced a factor which threatened daily to delay us. Sweep-wire and kites—essential implements—were being used up faster than we could obtain them. Besides the steady shipments from the United States, British manufacturers were producing at their maximum capacity. We had already



BY SETTING THE STAYSAILS, IT FREQUENTLY WAS POSSIBLE TO ADD A KNOT OR TWO TO THE SPEED MADE GOOD IN EVEN THE WORST OF WEATHER

drained the Admiralty of all that they could spare, and still the supply was insufficient.

The two repair ships, *Black Hawk* and *Panther*, therefore, had to lay aside the construction and repair work for the sweepers and chasers and devote their energy to the manufacture of kites, to enable the sweepers to continue operating.

Throughout the entire sweeping of the barrage we never had sufficient gear at any time to equip fully all sweepers for their contemplated stay at sea, and so it frequently was necessary after the day's work was over for one vessel, whose expenditures had been comparatively light, to go alongside one less fortunate and divide the supply of kites and sweep-wire that remained.

A TASK FOR IRON CONSTITUTIONS

Buoys, too, for marking the new fields were equally in demand, and, in order not to lose any of the valuable hours of daylight which could be used for locating the positions of the markers, it frequently was necessary for the Buoy-laying Squadron to spend the entire night in going from one sweeper to another to gather up the buoys which had been weighed after the sweeping of a group had been completed.

Think of the physical endurance this

LIFE ON BOARD THE SUB-CHASERS WAS CONCENTRATED HARDSHIP

With the ships rolling and pitching incessantly, the crews lived largely on cold canned foods, slept in wet bunks, in unheated compartments, and sank mines as fast as the sweepers cut them up. Small as they are, the sub-chasers are marvelous sea boats and were able to stay out in weather that would have driven far larger vessels into port.

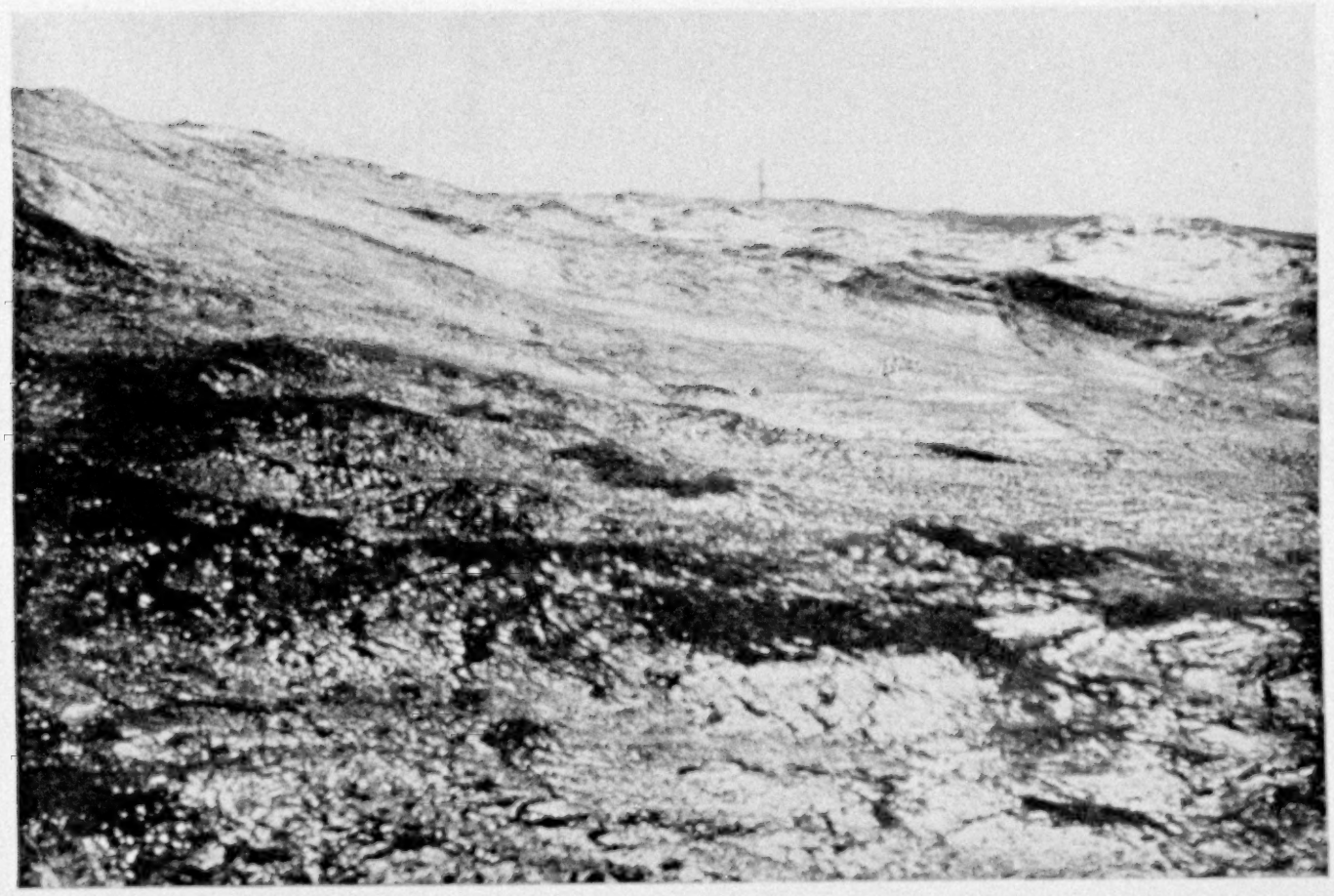
work required! The sweeping itself was fatiguing enough; it was an all-hands' job. But, after it was finished for the day, to spend a part, sometimes all, of the night in getting ready for the next day's work was a task for nothing less than iron constitutions.

Nothing could have been more magnificent than the splendid manner in which the officers and men stood up under the terrific strain. With never a murmur, never a complaint, sometimes going for months without setting foot on shore, these officers and men toiled on day after day.

A comparison of the British minesweepers with our own is interesting. Their crews consisted entirely of volunteers and were given nearly double pay, as well as a large bonus for each mine that they destroyed. We had no volunteers; it was the work of the Navy and we took it as such. We received no extra compensation nor any bonus for the mines that we destroyed.

On the 13th of September, 32 days after leaving Kirkwall, the fleet returned to port. Five and a half out of the six remaining groups had been completed. The British sweepers had not yet completed clearing their single line of mines to the southward of Group 8, and therefore only the northern half of our group could be cleared at that time. The British were expected to finish any day, after which we would be free to sweep the remainder of our group. When that was done Admiral Strauss desired to make a general test sweep of a large portion of the barrage to prove definitely that our work had been thoroughly done.

It was now the critical season of the



THE LAST TWO WEEKS OF MINE-SWEEPING WERE ACCOMPLISHED UNDER ALMOST SUPERHUMAN DIFFICULTIES

Storm followed storm with steadily increasing frequency and violence, until it seemed impossible that ships could actually be operating. The foremast of a sweeper can be seen in the center of the picture, while in the upper left-hand corner, perching on the crest of the wave, is the silhouette of a tiny sub-chaser.

year. A careful analysis of the meteorological records covering years of observation showed that in all probability the equinoctial storms could be expected within the next few days, and after they had broken the winter weather would set in with such fury that further operations would be practically impossible.

THE SWEEPERS ENCOUNTER A NORTH SEA STORM

Every minute must be saved. As soon as the ships had anchored the Admiral made a signal, asking how many could go out again at the end of three days. After 32 days at sea, it was asking a lot—more than could be expected, even of battleships—but in less than half an hour 23 of the sweepers reported that they would be ready! Actually, 28 of them managed to sail at the end of the third day.

Group 8 was finished in two days, but before the test sweep could be started the equinoctial storms bore down upon us with the violence of a hurricane. For three days the storm continued. The sweepers had sought shelter in the lee of Sanday Island, where the anchor chains of many snapped as if they had been made of cordage. In Kirkwall two of the ships were blown ashore and rescued only with the greatest difficulty. A large British transport, the *S. S. Vedic*, was driven on a reef a few miles north of where the sweepers lay and four of them were sent to her assistance.

DAYS OF MISERY

The following days were days of misery for the sweepers. Storm followed storm with such rapidity that the seas seemed ever to climb higher under the intermittent acceleration of the succeeding gales.

As long as it was possible to run before the seas, those sturdy little vessels would manage by one means or another

EVEN IN THE ROUGHEST WEATHER IT CONSTANTLY WAS NECESSARY FOR THE SHIPS TO GO ALONGSIDE EACH OTHER AT SEA TO TRANSFER SWEEP-GEAR OR BUOY MATERIAL

All hands were required to wear life-preservers, on account of the danger of being washed overboard by a mine explosion.

to rig out their sweeps. It seemed incredible that they could actually be working, as they perched for a moment on the crest of a wave, then disappeared almost from sight, as they slid into the hollows of the seas, pitching and rolling sometimes as much as fifty degrees each side of the vertical.

Still the work continued. The nights were even worse than the days, for then it was necessary to lie to, trying, sometimes vainly, to keep a tiny marker buoy in sight by playing a flickering searchlight on it, as the ship lurched to and fro, for it was imperative we should know our position in the morning.

THE DAY OF DAYS

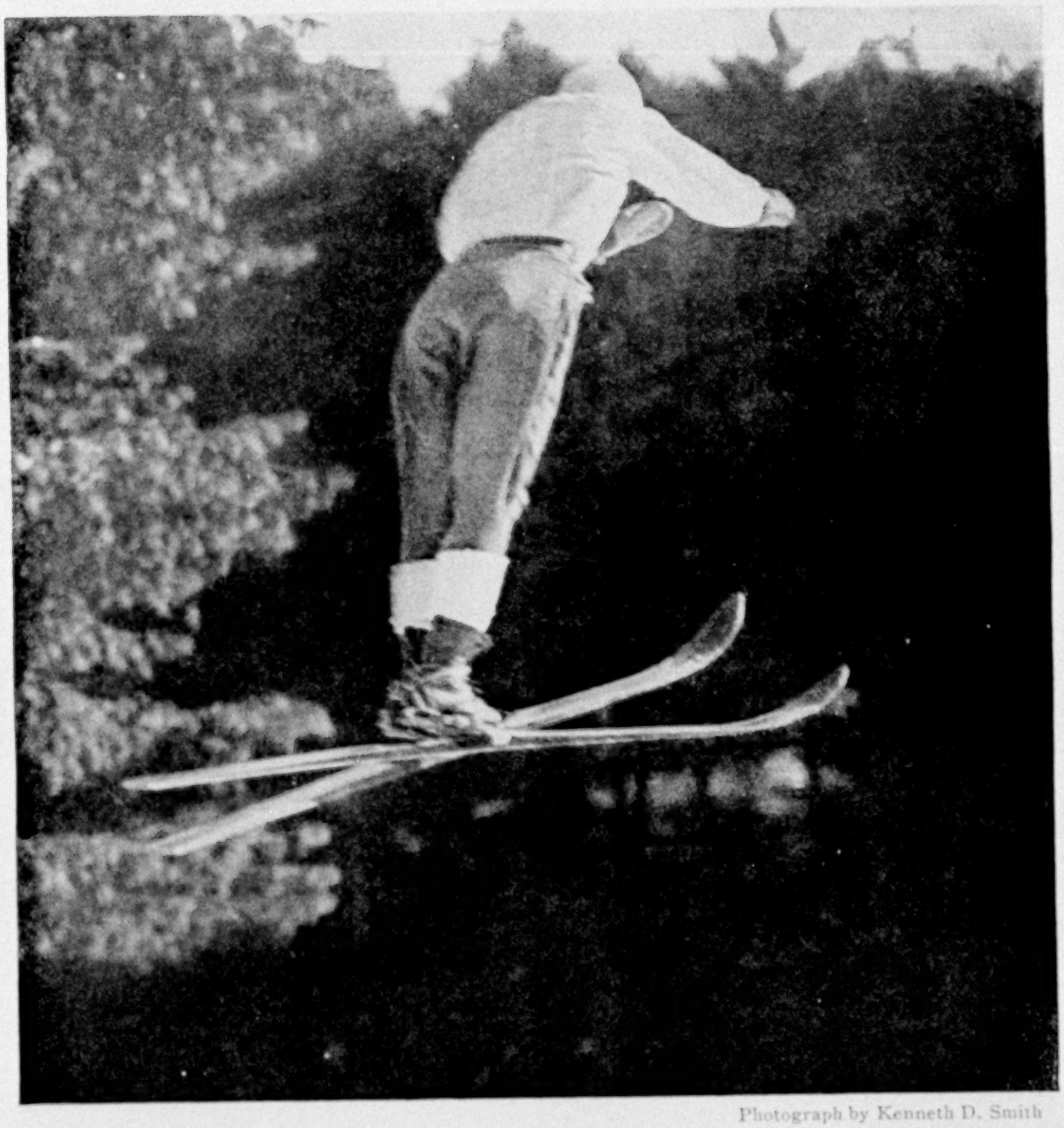
But at last our efforts were rewarded. That day of days came—the day which had at first seemed almost beyond attainment. And what a sight it was! The *Patuxent* had planted the last buoy, marking the goal of our ambition; and as the sweepers, pair by pair, steamed past it and slipped sweep for the last time, the exultation of the victorious conquest of an invisible enemy burst forth in whole-hearted cheers from every officer and man.

Whistles and sirens, too, were opened wide, while a wireless operator with a humorous turn coupled a phonograph to the radio-telephone and regaled the fleet with the welcome strains of "Home, Sweet Home!"

During the last two weeks 864 square miles of the barrage had been reswept to make absolutely certain that the work had been thoroughly done. Where approximately 35,000 mines had been anchored a few months prior, not a single one could now be found, except in one small pocket which had been skipped and was marked by buoys to enable it to be cleared on this final operation.

The test sweep was conclusive that the work had been thorough. The sagacious judgment of the Admiral in driving the force to the limit of physical endurance, coupled with the unparalleled loyalty of the officers and men, had enabled that gigantic task to be completed just as the violent winter storms were making further operations throughout the North Sea impossible.

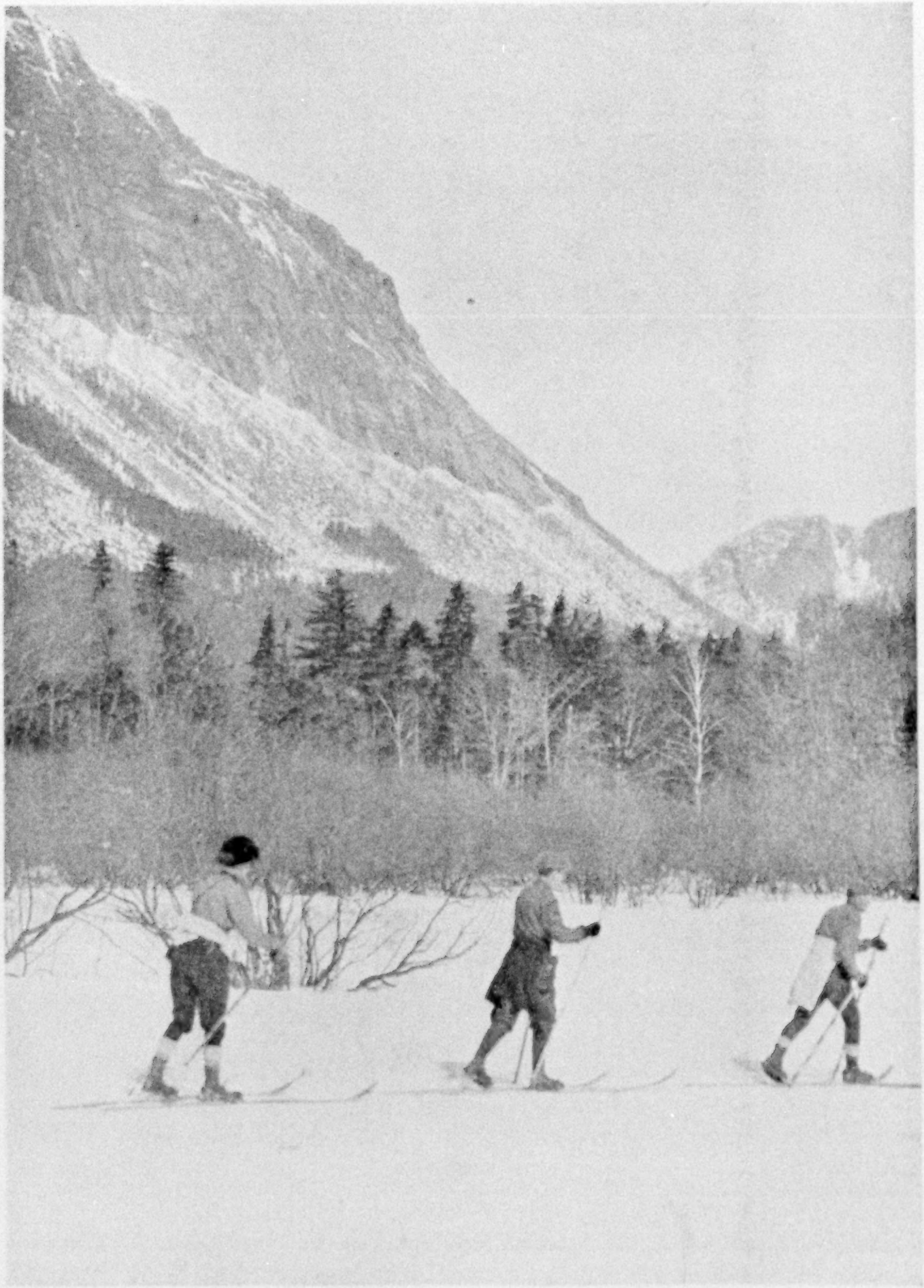
The mighty wall of mines which had confined the enemy's submarines and barred the commerce of the seas for better than a year had been destroyed, and the Navy's obligation to humanity, to the freedom of the seas, had been fulfilled.



Photograph by Kenneth D. Smith

A MEMBER OF THE DARTMOUTH OUTING CLUB SOARING ON SKIS: HANOVER, NEW HAMPSHIRE

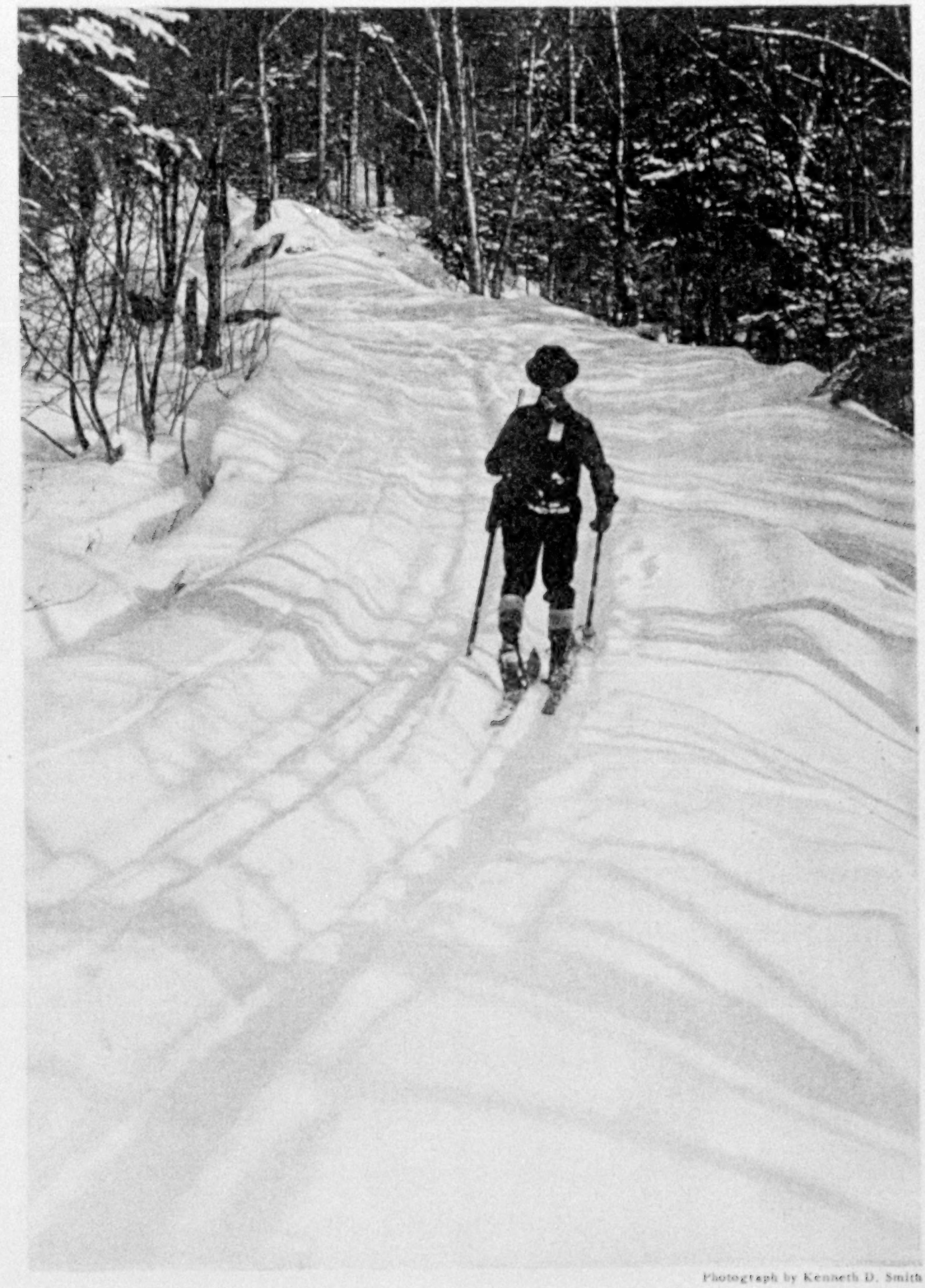
For an account of this thrilling winter sport, fostered by the famous New England College, alma mater of Daniel Webster, Rufus Choate, George Ticknor, George P. Marsh, Thaddeus Stevens, and Chief Justice Salmon P. Chase, see article on page 151.



Photograph by Kenneth D. Smith

SKIING IN FRANCONIA NOTCH, NEW HAMPSHIRE

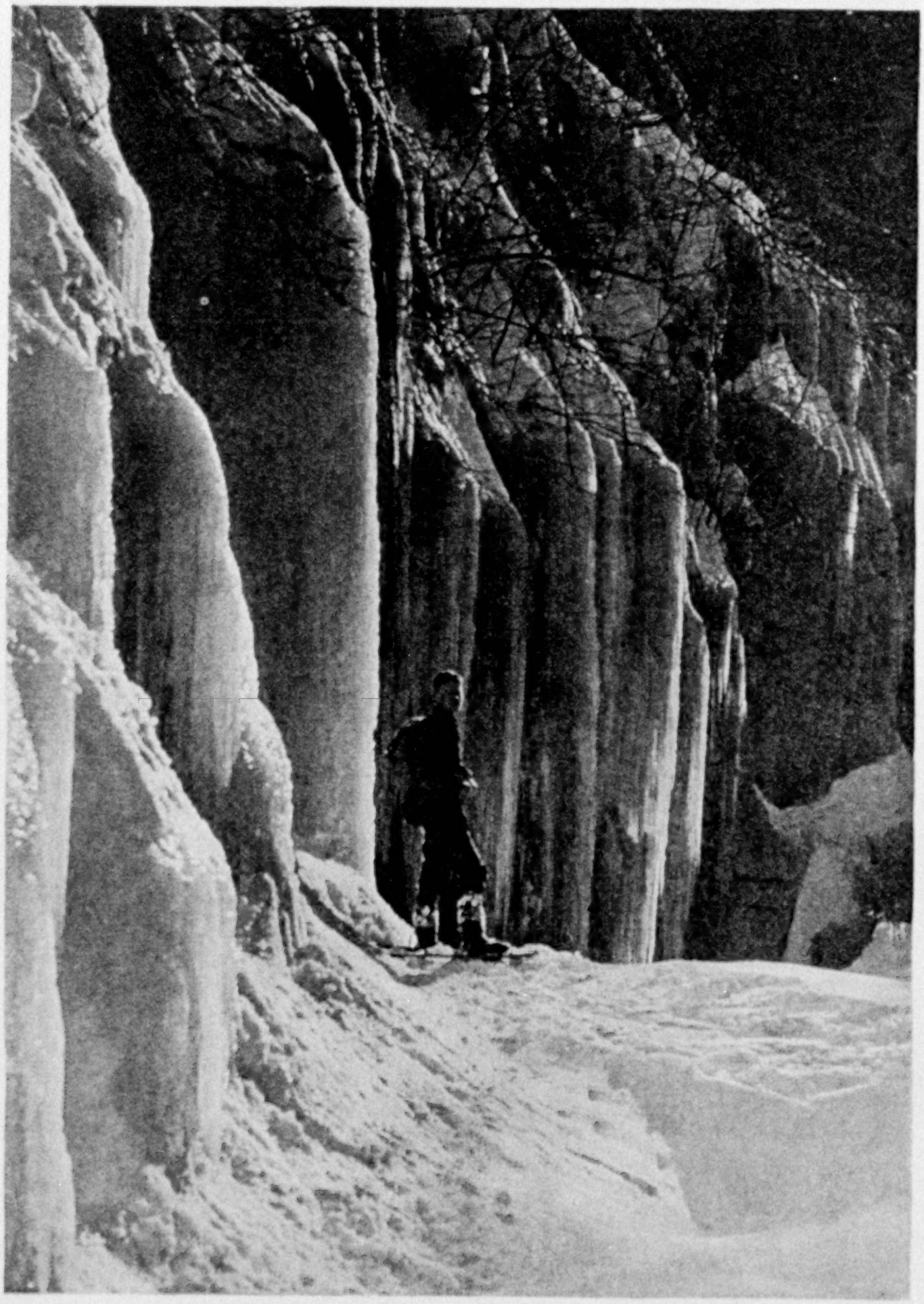
Three student members of the Dartmouth Outing Club starting for a long excursion over the frozen trail.



Photograph by Kenneth D. Smith

A LONE SKI RUNNER ON A WINDING TRAIL

The coming of winter does not drive the college man indoors. Rather it gives him a chance to exchange his football letter for the white badge of the Dartmouth Outing Club, which means long hikes to lovely scenes and long swift sweeps on skis down open fields of snow.



Photograph by Kenneth D. Smith

ICICLE FORMATION IN THE FLUME: NEW HAMPSHIRE

At this spot in the Franconia Mountains, a small stream flows between precipitous rocky walls, and the cold winds create wonderful ice formations from the water which filters down into this shadowy rift from the sunny slopes above.

Photograph by R. R. Sallows

THAWING OUT THE OLD PUMP

To the philosophic country-dweller, thawing out the pump whose throat has suffered from a night of exposure is as much a part of the day's work as "breaking out the roads" or blanketing the family Dobbin.

© R. W. Magee

THE CAPITOL AT NIGHT

When icy masses drape the evergreens and great gaunt limbs of the nation-old trees are edged in white, evening lights suffuse bright cheer across the glistening snow. Dark trees uprear their barren branches and frame within their iron-black tracery the leaden-hued dome of the National Capitol.

Photograph by Charles Martin

HOME OF THE PRESIDENTS IN WINTER. THE WHITE HOUSE: WASHINGTON

In none of the buildings of the Capital has the spirit of colonial America been so well preserved as in the White House, and when Washington is whitened with one of its infrequent snowfalls the Executive Mansion seems more of a home than ever. The equestrian statue of General Jackson is an interesting feature of the view from the President's front windows.

Photograph by J. Manning McLeod

A FORD IN AMERICA'S MOST BEAUTIFUL CITY PARK

Many residents of the Nation's Capital ride or tramp to the silent places along Rock Creek, from which the park takes its name, there to listen to the "tongues in trees, books in running brooks" and "sermons in stones." As darkness falls, the timber wolves, confined near by, call loudly to their departed sires across the wide reaches of time, and only the churning of the motor cars rushing through the ford now and then remind one that a large city overhangs the spot.

© Photograph by Haynes (St. Paul), 1919

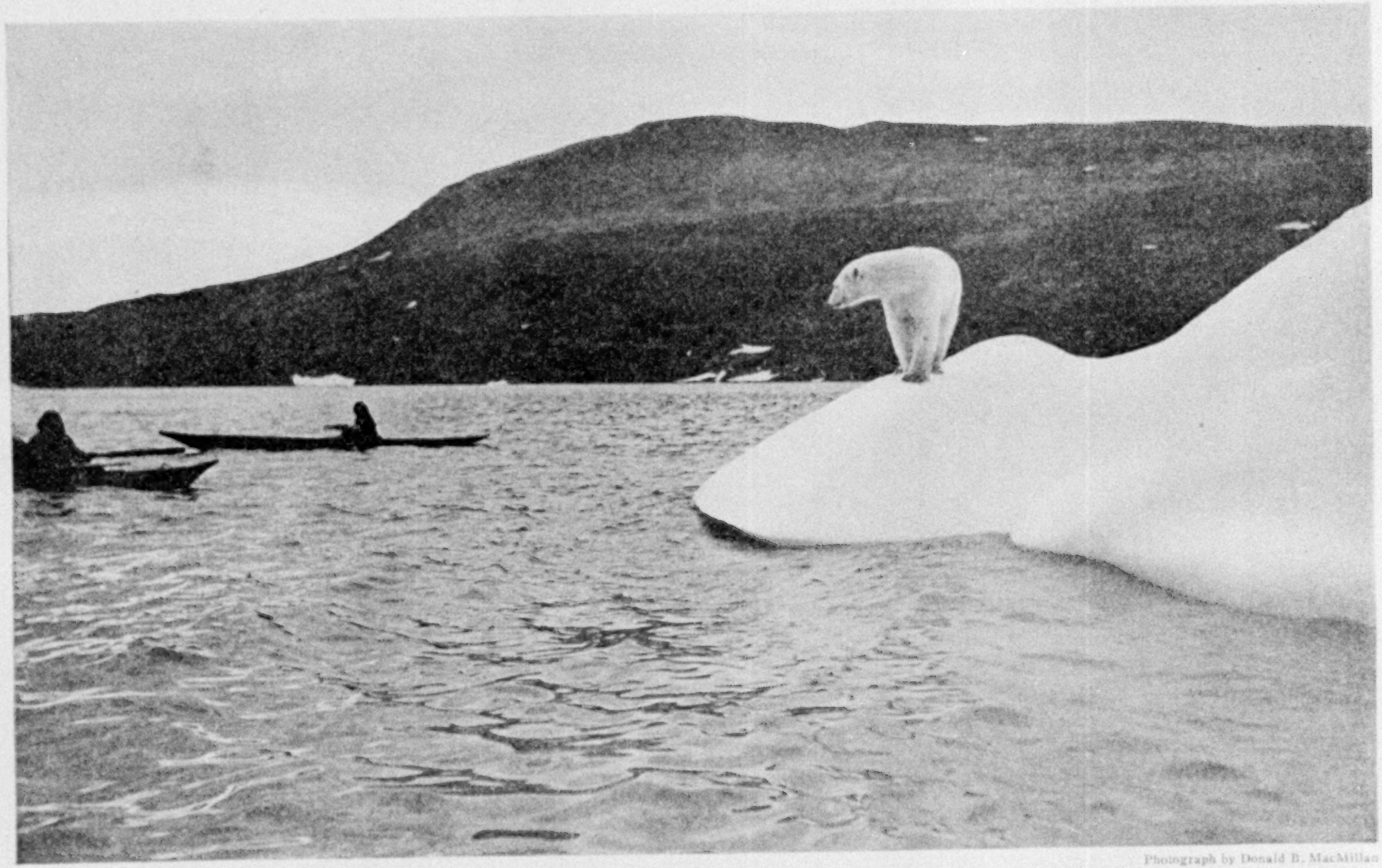
THE NORRIS GEYSER BASIN IN WINTER: YELLOWSTONE PARK

These geysers form a versatile troupe. Monarch, the largest, is exceedingly irregular, but gives notable exhibitions on occasion. Minute Man is much smaller, but has won its name for frequent eruptions. Constant is active much of the time and Hurricane, still smaller, is continuous. Because the geysers of the Norris Basin allow artistic temperament to prevent a reliable exhibition schedule, it is small wonder that the thousands of tourists prefer to go on to witness the really splendid and regular eruptions of Old Faithful.

Photograph by Donald B. MacMillan

THE GEOGRAPHIC EXPLORER BUILDING A SNOW SHELTER FOR THE NIGHT

When the day's trail is ended, great blocks of snow, carved from the all-encompassing cold, must be formed into a rude shelter to keep out the bitter wind of the frozen north.



Photograph by Donald B. MacMillan

THE MONARCH OF THE NORTH, MAJESTIC IN HIS CALM THOUGH RINGED ABOUT BY FOES

The photographer has caught the dramatic moment when the polar king is debating whether to give battle or to flee. His massive form stands steady as the berg of which he seems a part while he awaits attack.

Photograph by Curtis & Miller

A NATURAL LOOKOUT FROM MOUNT BAKER, WASHINGTON

From the 10,800-foot summit of this isolated offshoot of the Cascade Mountains one can look over into Canada, for Mount Baker is one of the northernmost peaks of the United States. It is a massive volcanic cone, but has been quiescent for half a century. The view from its summit embraces winding rivers and snow-clad mountains, sparkling Mosquito Lake and primeval forest.

XUM

Photograph by Jean Gabetell

THE FRIENDLINESS OF TREE AND SNOW

When snow and frost give life to the dead black of the autumn branches, the trees frame vistas which are beautiful because the snow lies thick on cabin roof and mountain slope, softening all harsh lines. Just as the spring sun allows his ardent glance to be hidden by a leafy bower, so the modest willow and the sturdy ash efface themselves before the distant scene which their bare branches frame.

Photograph by A. E. Churchill

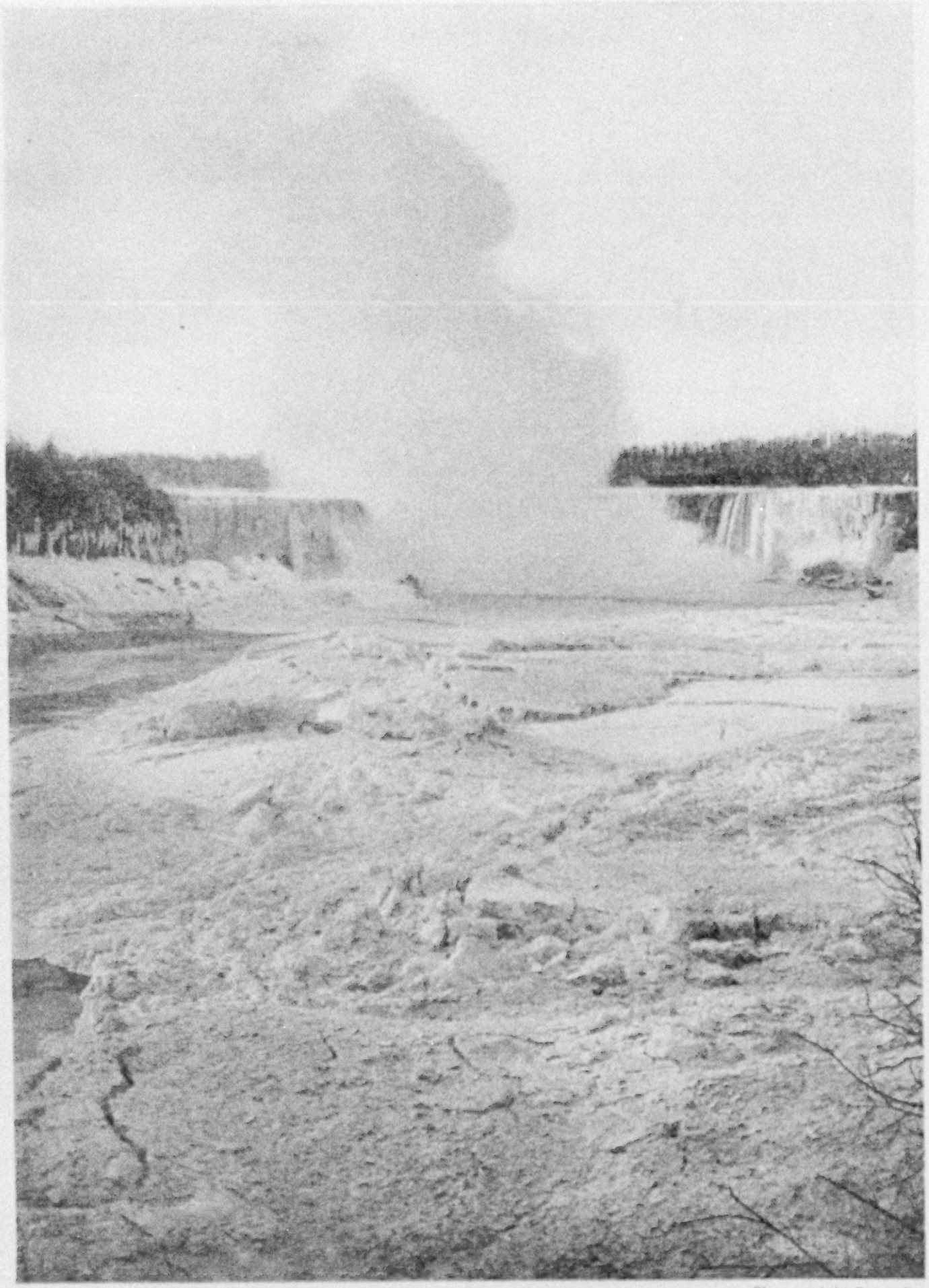
NEW YORK CITY DURING A SNOWSTORM

When heavy snowfall drives Manhattan's traffic to subway and elevated, the call goes forth for men to battle with the white army of the elements whose enveloping movement threatens surface traffic. Then the scene on lower Fifth Avenue presents a truly wintry picture.

Photograph from Detroit News

DETROIT'S WEDDING-CAKE ICE FOUNTAIN

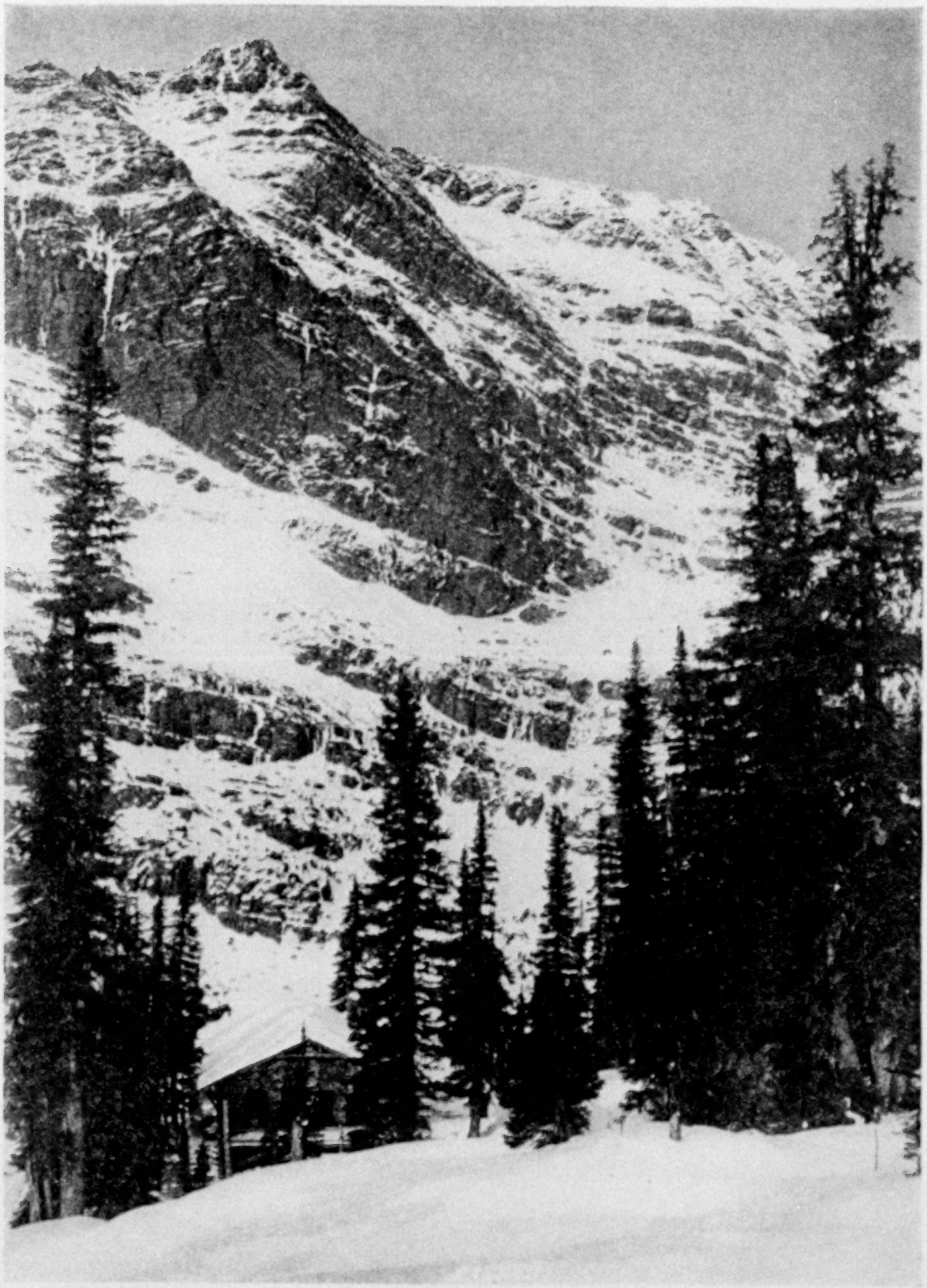
In Washington Boulevard at Michigan Avenue, Jack Frost and the Detroit City Water Works collaborate in the erection of this towering crystal confection, the beauty of which is as unstudied as if it were some natural geyser transfixed by the breath of Boreas in some remote wilderness instead of in a city park.



Photograph by Ernest Fox

NIAGARA FALLS IN ITS WINTER ARMOR

Impressive as Niagara is when its rush of waters appals the beholder and clouds of spray rise from the chaos, in the midst of which a cockle-shell boat impudently noses the flood, it does not surpass the view in winter when the Frost King has spanned the river with heaving masses of ice and concealed behind alabaster columns the mighty torrent as it thunders toward the sea.



Photograph by A. J. Baker

SPERRY CAMP IN GLACIER NATIONAL PARK

What is more beautiful than a distant mountain peak poised majestically on a "throne of rocks, in a robe of clouds, with a diadem of snow"? In winter, when the mass of driven white stretches unbroken from the lofty summit to the timber line, there is a grandeur that no other mood of the mountain conveys.

Photograph by A. B. Wilse

A FROSTY MORNING ON THE OPEN ROAD

What Spanish moss is to the trees of the far South, the frosty touch of winter is to the roadside trees of the colder North. Shiny trails which bright steel runners make and hard pressed lumps of snow, thrown from the flying feet of man's best friend, mark the journey past such lovely scenes to warmth and comfort by the blazing fire within the home.

SKIING OVER THE NEW HAMPSHIRE HILLS

A Thrilling and Picturesque Sport Which Has a Thousand Devotees in the Dartmouth Outing Club

By Fred H. Harris

CLIMATE and geography mold the sports of colleges as well as of nations.

The fact that Dartmouth College is situated in the sequestered town of Hanover, New Hampshire, among the foothills of the White Mountains, where the hand of winter lies heavy on the land during a large part of the scholastic year, is responsible for the organization of an athletic association unique in the annals of student life in America.

Unlike football, baseball, hockey, and basket-ball teams, each of which in its ultimate development enlists the active efforts at play of a limited number of athletes, the Dartmouth Outing Club is composed of more than a thousand members—nearly two-thirds of the entire student body.

The long months of cold and the deep snows that serve to isolate this college community have, through the Outing Club, been converted into an asset rather than a liability, and today Dartmouth is a pioneer institution in the movement to enlist the entire student body in healthful sport, instead of offering the college "letter" only to those whose physical prowess is proved.

In the Outing Club all who love the wide spaces, all who delight in the stillness of the winter woods, all who feel the lure of the frozen trail, are welcomed as of the elect.

THE CLUB'S EARLY EXCURSIONS

Beginning modestly, with sixty members a few years ago, the Club in its incipiency confined its excursions to Saturday afternoon jaunts on skis and snowshoes. Toward the end of the afternoon a halt would be called and coffee made over a crackling fire, under the shelter of snow-laden trees. The trips grew in frequency and the parties grew in number. By the end of the first season scores of students had become interested in the excursions, and, as Thoreau said of his Concord, the members "had traveled a great deal in the vicinity of Hanover."

Today the Saturday afternoon trips of old have expanded into week-end journeys; the radius of the excursions has increased from a few miles to tens of miles, and instead of confining their explorations to the foothills along the banks of the frozen Connecticut, the enthusiasts now make Mount Washington, the highest peak of the North Atlantic States, their furthest objective. The camp-fire of crackling twigs under the trees has been superseded by the cheerful glow of logs in the open fireplaces of comfortable cabins, which shelter those who wish to extend their outing overnight.

BUILDING A CHAIN OF CABINS

The first of the chain of cabins for the week-end devotees of the Outing Club was established on the site of an old lumber camp at the base of Moose Mountain, seven miles from the college. Built through the efforts of a dozen club members who elected to spend their Easter vacation as carpenters, and through the material assistance of a Boston alumnus, Franklin P. Shumway, its immediate popularity was so pronounced that no propaganda was necessary to insure the enthusiastic support of the student body for the movement subsequently inaugurated by another alumnus, the Rev. J. E. Johnson, of Philadelphia.

Mr. Johnson has raised an endowment fund of $40,000 for the construction and maintenance of these combination rest-cabins and rustic club-houses which extend, at intervals of a day's trip apart, from the college campus to the slopes of the White Mountains.

Close beside Moose Mountain Cabin flows a brook which has been dammed to form a deep pool, and the fact that this

Photograph by Fred H. Harris

COMING THROUGH WOODS WITHOUT CAPS OR SHIRTS

Not only has the Outing Club improved the physical well-being of Dartmouth's student body, but faculty statistics show that scholarship has profited by the week-end excursions of skiing parties.

Photograph by Kenneth D. Smith

SHOOTING THE SNOW CHUTES ON A SHOVEL

A novel way of traversing the skiing course to the landing stage of the big jump at Hanover.

Photograph by Fred H. Harris

READY FOR THE WINTER ASCENT OF THE TALLEST PEAK IN THE NORTH ATLANTIC STATES

Until the feat was actually accomplished by Dartmouth students, a ski climb to the summit of Mount Washington was considered impossible.

Photograph by Kenneth D. Smith

"THE BEST DRINK ON EARTH"

After skiing for fifteen or twenty miles without drinking, one appreciates water. Drinking out of Profile Lake, in Franconia Notch, White Mountains.

WHEN THE HOLLOWS OF THE WOOD ARE COVERED WITH WINTER'S CARPET

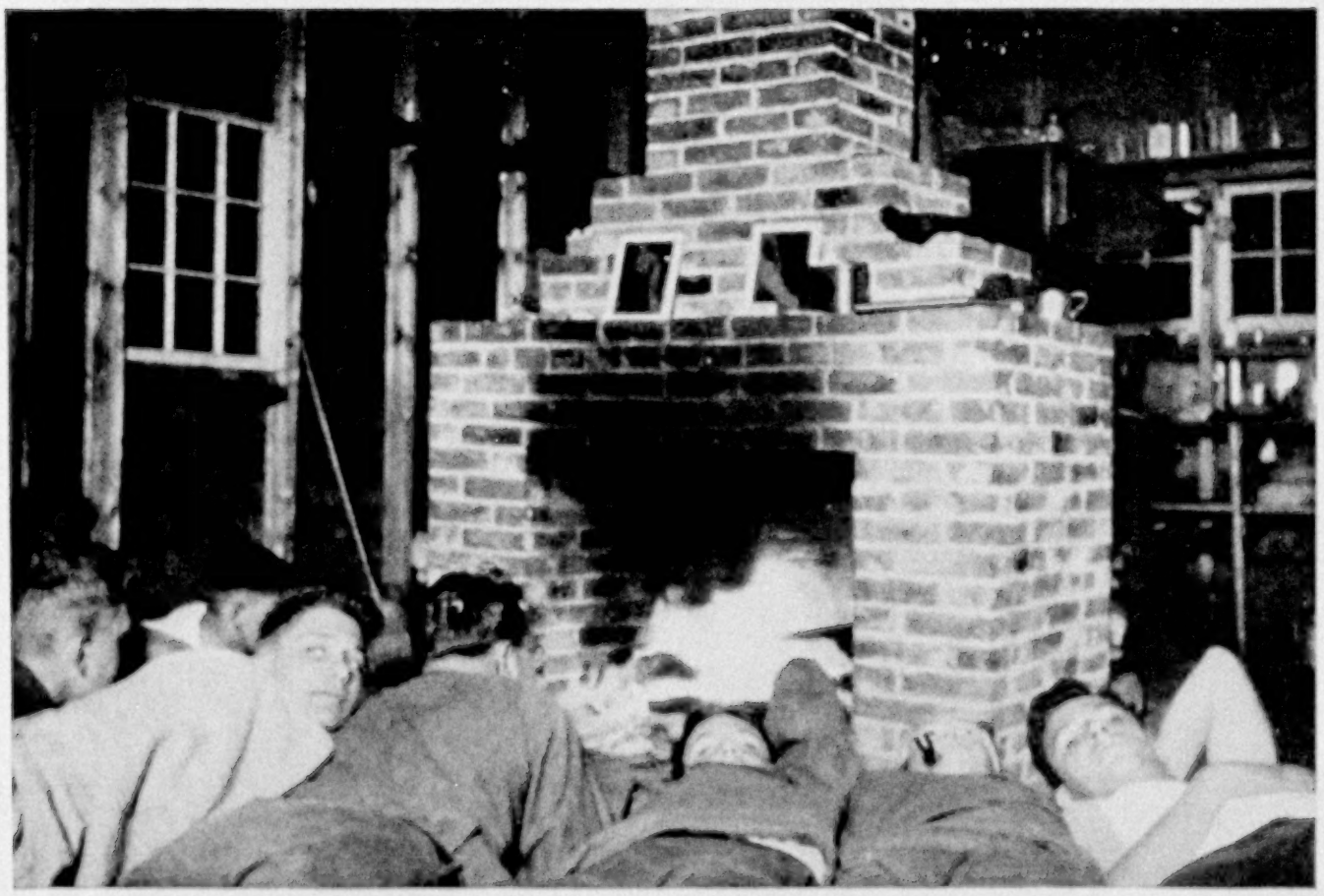
Photographs by Fred H. Harris

THE OLD SWIMMIN'-HOLE IN A NEW MOOD

Here is a test of bodily vigor which few city dwellers would care to undergo. Near the Moose Mount Cabin of the Dartmouth Outing Club the members have dammed a small brook to make this winter open-air bath. It is usually necessary to break a sheet of ice before the bather can take his plunge.

Photograph by Kenneth D. Smith

MEMBERS OF THE DARTMOUTH OUTING CLUB ON TOP OF MOUNT LAFAYETTE: ONE OF THE ANNUAL WINTER PILGRIMAGES OF THE TRAIL-FOLLOWERS



Photographs by Fred H. Harris

SLEEPING ON THE FLOOR OF ONE OF THE CABINS

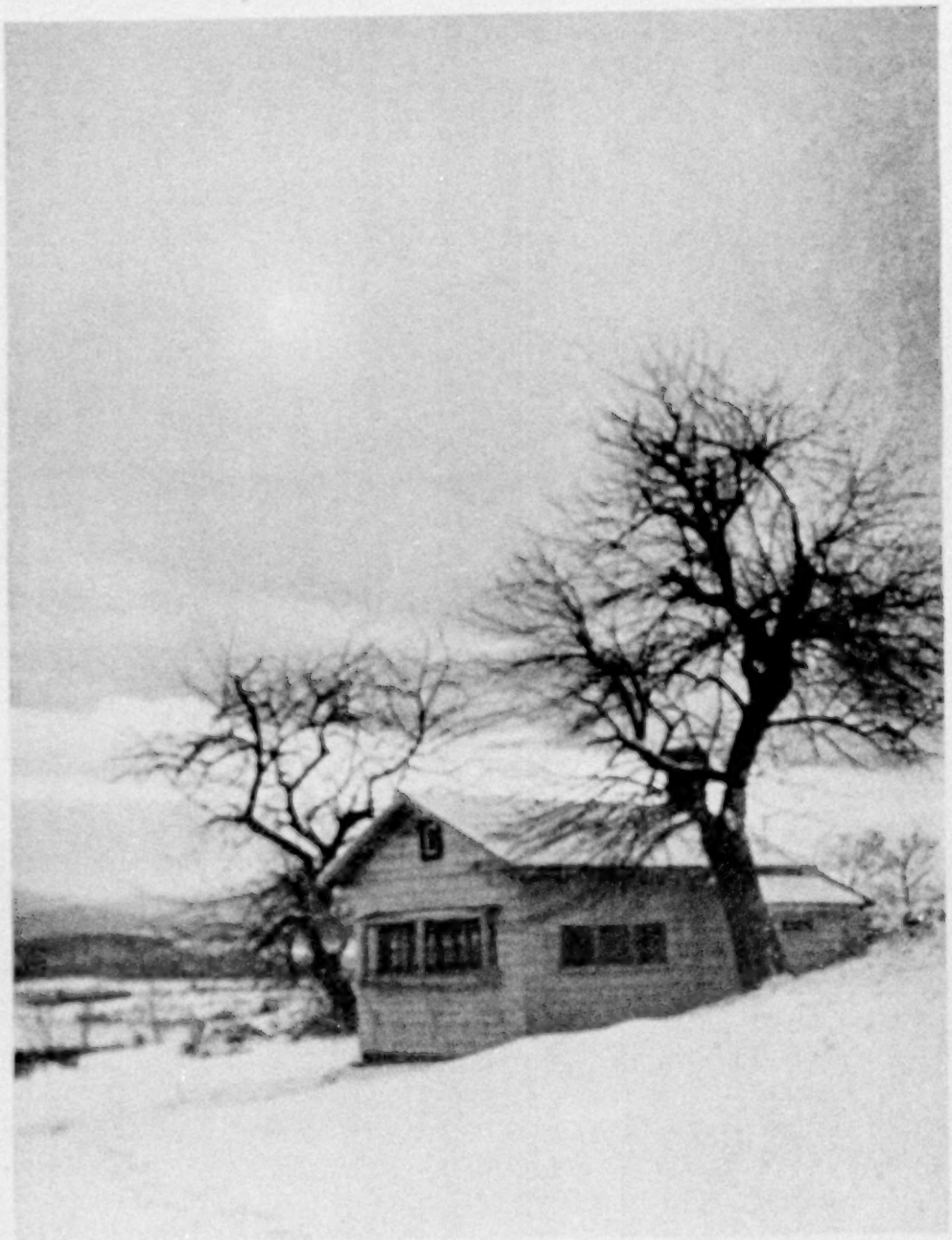
Gathered about the roaring logs of an open fireplace, these Dartmouth Outing Club enthusiasts do not even demand the comfort of bunks.

Photograph by Kenneth D. Smith

NEARLY SUNDOWN IN THE NEW HAMPSHIRE WOODS

A solitary student skiing along the banks of the Connecticut a mile from Dartmouth College.

XUM



THE LAST CABIN OF THE CHAIN

A big open fireplace and enough bunks to accommodate thirty tired hikers are the chief architectural features of these Dartmouth Outing Club camps. A cooking-stove is also installed in each cabin.

THE CUBE MOUNT CABIN, IN A GROVE OF BIRCHES

It is the law of the trail that each party shall leave a supply of dry logs stacked against the chimney, for the use of the next traveler who happens along.

Photographs from Fred H. Harris

open-air bath, available only after the thick crust of ice is broken, is in use throughout the severest winter weather needs no commentary to prove the hardihood which the Outing Club engenders in some of its members.

THE MEANDERINGS OF THE TRAIL

An Outing Club trail from Hanover to the White Mountains is a skiway leading through grandeurs of winter scenery wholly unknown to those who nestle beside steam radiators and gaze out upon a world blanketed in white, or who gain their sole idea of a snowclad landscape through the windows of automobile or swift-flying train.

Sometimes the trail, in companionable fashion, follows some meandering back-country road; then it dips off suddenly into the forest to seek solitude in the solemnity of Nature's cathedral trees. It descends into deep ravines, it mounts billowing slopes of white; sometimes it skirts the edge of a logging camp desolate in its evidences of former habitation. Now it runs straight over hedge and copse, now it sinuously mounts a gleaming summit from whose eminence the winter world unfolds in all its splendor.

Twenty-three miles beyond Moose Mountain Cabin stands the Cube Mount Station, tucked away in a grove of white birches, with the evergreen slopes of the mountain rising as a background for the picture. To the west the noble panorama of the Green Mountains unfolds along the Vermont skyline.

Sheltered by a cluster of whispering pines on the eastern shore of Armington Pond, a third cabin is built in the shadow of Piermont Mountain, which rises abruptly on the opposite shore. A short walk from the cabin is the famous Lake Tarleton Club, and some distance further along the trail which winds through Webster Slide is the Great Bear Cabin, deriving its name from the fact that students who were prospecting for the site found the tracks of a black bear in the neighborhood.

A FIVE-MILE SLIDE

Over the shoulder of Mount Moosilauke goes the traveler after he leaves Great Bear Cabin, and from this eminence the ski sportsman has one of the most delightful experiences of his excursion, as he slides almost without effort for a distance of five miles to the picturesque hamlet of Wildwood.

One of the most popular camps of the Dartmouth Club is located in the famous Agassiz Basin, ever to be associated with the great naturalist's elaboration of his theory of glaciers. Here is the Lost River District, little known to the average White Mountain tourist of the summer season, but one of the most interesting regions of the New England States.

Lost River is important for what it has been rather than for what it is. In the distant past great torrents of water from a melting glacier flowed here, and once an earthquake shattered the mountainside, hurling huge boulders into the bed of the river, practically burying the stream. Immense "potholes" were carved in the rocks by the action of the water, enabling the student of geology to read aright the sermons which that mystic, Nature, has written in the stones.

Near the point where the river disappears for its journey of a quarter of a mile underground is the cosy club-house of the Society for the Preservation of New Hampshire Forests.

THE PAGEANT OF THE PRESIDENTIAL RANGE

After passing North Woodstock, which lies beyond Agassiz Basin, the Outing clubman comes to Profile Notch, with its famous "Old Man of the Mountains." Then for a swift slide down Three-mile Hill to Franconia, north to Littleton, to Manns Hill, and finally to Skyline Farm, where ends the trail. Here the whole pageant of the Presidential Range of mountains is spread before the view of the winter visitor—a matchless picture of serrated summits and tree-clad slopes wrapped in an Arctic mantle of iridescent beauty.

But hiking is not the be-all and the end-all of the Dartmouth Outing Club. There is the spectacular Winter Carnival, staged for the delight of the friends of the students as well as for their own pleasure.

During this "Mardi Gras of the North"

Photograph by Kenneth D. Smith

MARIAN FAIRFIELD, OF HANOVER, AT THE MOMENT OF LANDING FROM A SKI JUMP

This young miss has just gone over the "big jump" of the Dartmouth College skiing course—a feat which many experienced athletes have refused to attempt.

there is a succession of spirited races—ski and snowshoe sprints, cross-country ski races, testing the stamina of the contestants as do few other college sports, and obstacle races.

The crowning event of the carnival, however, is the ski-jumping contest, which is to the occasion what the chariot race of the Olympic games was to the ancients. Thousands of spectators can be accommodated on the slopes surrounding Dartmouth's great ski-jumping course.

THE SKI-JUMPING COURSE

The approach of the ski-jump is down a steep 300-foot pathway cut through a pine forest. At the top is a wooden trestle, which enables the contestant to acquire a tremendous initial momentum for his rush down the course to the "jump" itself, which is a level platform

Photograph by Kenneth D. Smith

A SKI DASH, ONE OF THE MANY RACING EVENTS OF THE ANNUAL WINTER CARNIVAL HELD BY THE DARTMOUTH OUTING CLUB, HANOVER, NEW HAMPSHIRE

fifty feet long, with a "take-off" eight feet above the slope.

The steep slopes of the hill have been so terraced that the spectators are enabled to get a close view of the jumper from the moment he begins his spectacular slide.

Poised 150 feet above the heads of the onlookers, the contestant hesitates for a moment, breathes deeply, and then waits with every muscle taut and every nerve atingle for the signal. It is given. Instantly he tips over the brink of the trestle, at the same time assuming the crouching position which offers the least possible wind resistance to his flight.

As he sweeps down the glassy incline he keeps his body in perfect balance, his skis together and parallel. As he gains impetus he resembles a human missile shot from some gigantic catapult.

WHAT WILL HAPPEN WHEN HE HITS?

Out upon the jumping platform he slides with lightning speed, and at the critical moment, with all the strength of his lithe body concentrated in his knees, he springs. Like a soaring bird, he launches upward and out into space. For a moment he seems to pause in midair, then quickly describing an arc, down, down, down, he swoops with the speed of thought.

What will happen when he hits? This is the harrowing question which comes to the mind of every spectator who is watching the thrilling sport for the first time. But he does not *hit;* he seems merely to *meet* the snow track at the bottom of the jump. And that is exactly what does happen; for, as the jumper rushes through space, he is describing a curve of thirty degrees, and the track is so arranged that at the point where he alights the slope also inclines at an angle of thirty degrees, and the moment of contact is thus robbed of all its shock.

The jumper, provided he alights with his skis together and at the correct angle, simply glides on, at terrific speed, until, with a perfectly executed telemark swing, he brings himself to a halt in a whirl of snow.

These contests do not take place among the students of Dartmouth only. McGill College, of Montreal, Canada, frequently

sends a team of jumpers to the carnival, when the struggle for supremacy assumes an intercollegiate and an international flavor.

EXECUTING A SOMERSAULT ON SKIS

Every jump brings a thrill to spectator as well as to participant, but the supreme moment of the carnival comes when a master of the skis executes some such spectacular antic in the air as a forward somersault.

As the stellar performer prepares for the jump, a hush sweeps over the spectators, for every one knows that unless his timing is accurate to the fraction of a second and his spring from the platform is perfect, contusions and broken bones will be his reward.

Down he rushes to the platform. A sudden contraction of all the muscles of the body, a magnificent leap into the air, a somersault completed at the instant of landing—all in the time of a held breath! There is wild applause from the relieved spectators, as they realize that the sensational "stunt" is successfully accomplished.

In many respects ski jumping is an even more exhilarating sport than flying. As one shoots out and down through the keen, bracing air with no windshield to protect him, the sensation is beyond description. Unlike the aviator, the ski jumper has no ailerons, no rudder, no "flippers" to aid him. The whole success of the venture depends solely upon the human machine, upon the proper co-ördination of the muscles and upon the ability of the jumper to judge with absolute accuracy the precise moment for the spring.

SKIING UP AND DOWN MT. WASHINGTON

When the snows begin to melt around Hanover in the spring the Outing Club gives its final winter party—a three days' trip into the White Mountains. From headquarters at the foot of Mount Washington, the sportsmen climb the mountain, plunge into Tuckerman's Ravine, and see aspects of the outdoors which are never revealed to summer visitors. The snows have begun to disappear in the southern portion of the State, but drifts to a depth of 100 feet in the ravines are still to be found here.

Photograph by Kenneth D. Smith

FRONT VIEW OF A SKI JUMPER IN FLIGHT

Not even aviation can provide more thrilling sport than that afforded the expert on skis.

© E. G. Dewey

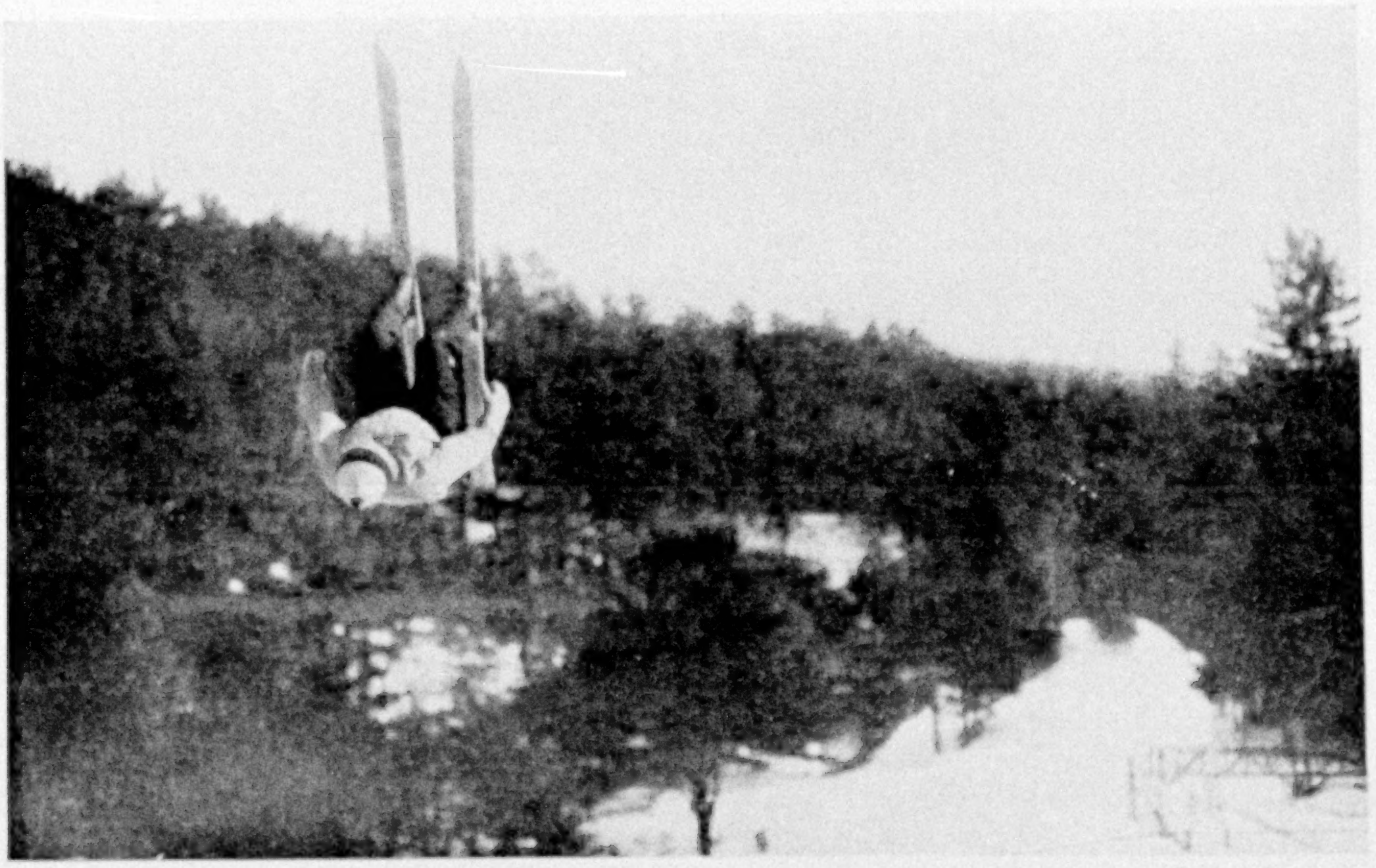
SOMERSAULTING THROUGH SPACE ON SKIS

The first of a remarkable series of photographs illustrating one of the most thrilling exhibitions of the mid-winter carnival at Hanover, New Hampshire.

© E. G. Dewey

THE SOMERSAULT HALF COMPLETED

This spectacular test of skill is accomplished in a few seconds, but it provides the thousands of spectators a topic of conversation for months.



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THE THIRD EVOLUTION OF THE SOMERSAULT

One of America's foremost adepts in the performance of this "stunt de luxe" is a Dartmouth sophomore, John Carelton.

© E. G. Dewey

HE WILL BE HEAD-UP WHEN HIS SKIS TOUCH THE SLOPE

The ability to judge the exact moment for the leap into the air while traveling at the rate of forty miles an hour is an essential factor in the successful accomplishment of this feat. The knees act as shock-absorbers.

Photograph by Dr. Leland Griggs

ALL OFF TOGETHER

A ski threesome takes the air for the downward drop at the Dartmouth "Mardi Gras of the North."

On several occasions members of the Club have succeeded in climbing on skis to the summit of Mount Washington, a feat which, until accomplished by these Dartmouth students, was deemed impossible.

The difficulty of the ascent is not to be discounted by its accomplishment, however; and the descent, especially down the icy, wind-driven slopes above the tree line, is an even more hazardous test of skill.

Usually the ski men rope themselves together like the scalers of Alpine crags; but, once over the dangerous part of the course, the stalwart mountaineers find rare delight in the long glide down the carriage road from Half-way House.

The start for this last fascinating stage of the trip is usually made in the late afternoon, when the light is fading and the snow particles come hissing down from the heights, bringing with them a penetrating cold.

Now there is no inclination on the part of the travelers to tarry. With a vigorous push of the ski poles, the rush begins.

On the steep slope the speed is quickly accelerated to forty miles an hour, as the skis sing and whistle over the snow. On through the woods, at ever-quickening pace, the hikers go, sometimes forced from the path by the rapidity with which they take the curves in the road. Not infrequently there is a spill in the snow, as the moon casts deceptive shadows along the way.

Now and again the incline flattens out almost to a plane and the pace slackens instantly, but in another hundred yards the traveler is again speeding before his shadow.

It is a wonderful course, 21,120 feet in length, with a drop of 2,000 feet, and a member of the Dartmouth Outing Club has set a record of twelve and a half minutes for the journey!

WINTER RAMBLES IN THOREAU'S COUNTRY

By Herbert W. Gleason

Author of "Through the Year with Thoreau"

With Illustrations from Photographs by the Author

"I have traveled a great deal in Concord."—Thoreau.

The National Geographic Magazine being pre-eminently a magazine of travel, it is not inappropriate to call the attention of its readers to the journeyings of one of the most original, observant, and wholly entertaining travelers whom the continent of America has produced. To be sure, his travels did not cover a very wide field geographically; they consisted chiefly of daily walks afield or boating trips on the river to various points in his immediate neighborhood; yet they resulted in giving to his name a higher place in the temple of fame than that of many another who has roamed the seven seas and encompassed the ends of the earth.

Henry David Thoreau was born in Concord, Massachusetts, a little more than a century ago, and, with the exception of a few brief and unimportant excursions away from home, his entire life of forty-five years was spent within the confines of his native town.

So far, however, from lamenting this as a misfortune, he actually gloried in the supposed limitation. "It takes a man of genius," he declared, "to travel in his own country, in his native village; to make any progress between his door and his gate. If a man is rich and strong anywhere," he confided to his journal, "it must be on his native soil. Here I have been these forty years, learning the language of these fields that I may the better express myself.

Preferred his own village to the proudest Paris

"If I should travel to the prairies, I should much less understand them, and my past life would serve me but ill to describe them. Many a weed here stands for more of life to me than the big trees of California would if I should go there."

Somebody once suggested to him a trip to Paris. But why should he go to Paris? "It would be a wretched bargain to accept the proudest Paris in exchange for my native village. At best, Paris could only be a school in which to learn to live here, a stepping-stone to Concord, a school in which to fit for this university."

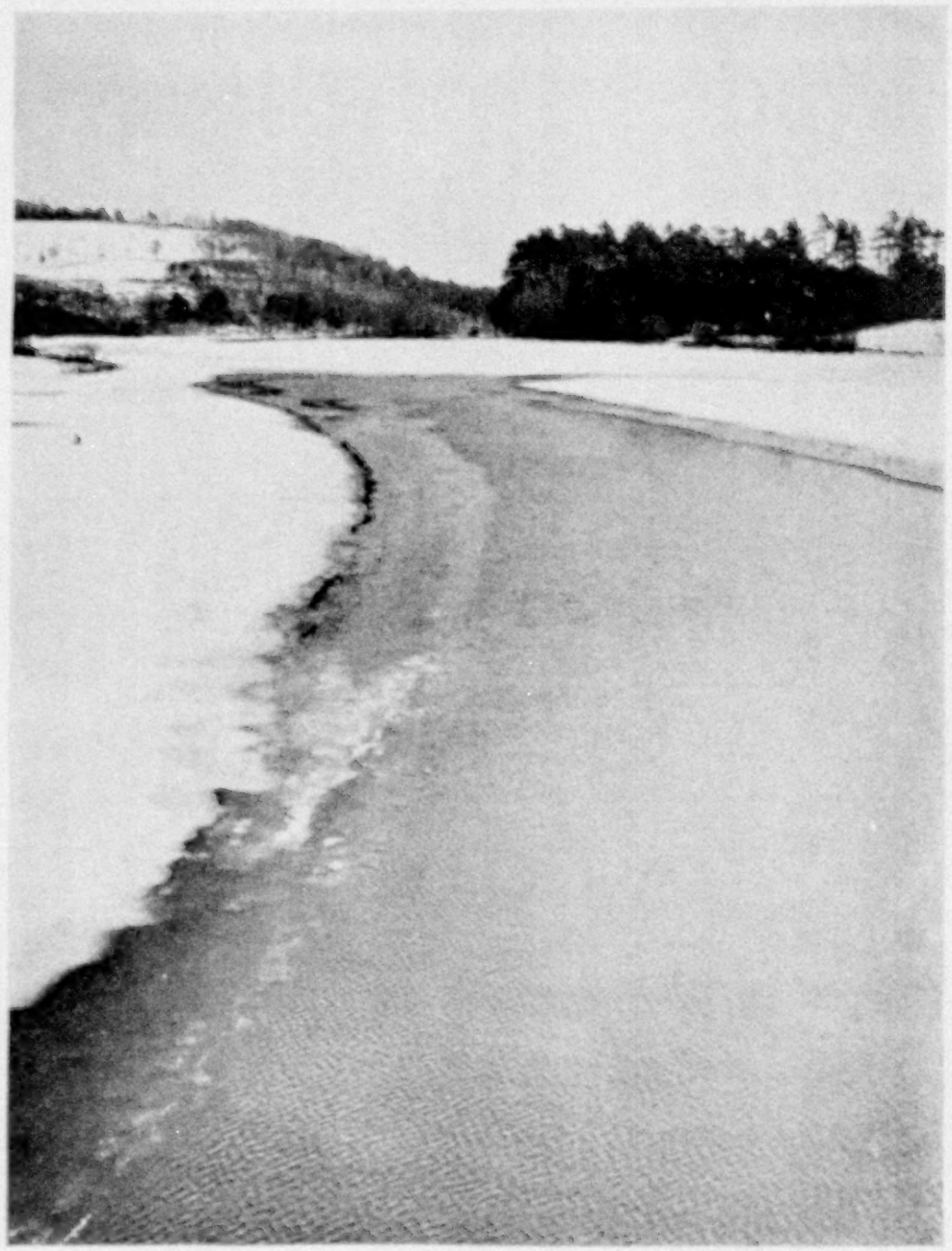
"The only travel that is good"

And so he records his solemn conviction: "If these fields and streams and woods, the phenomena of nature here, and the simple occupations of the inhabitants should cease to interest and inspire me, no culture or wealth would atone for the loss."

> "My feet forever stand
> On Concord fields,
> And I must live the life
> Which their soil yields."

Now, all this, of course, is at a wide remove from commonly accepted ideas, and many a Cook's tourist will smile superciliously on reading this pronunciamento of a confirmed stay-at-home. Yet Thoreau never meant to disparage foreign travel, as such. Indeed, from his own account it may fairly be assumed that his familiarity with the best books of travel far exceeded that of most people of his time, and certainly few people of any time have possessed, both by nature and training, a keener appreciation of the advantages which travel brings.

He was simply trying to enforce, in somewhat vigorous fashion, the truth that to a man with receptive mind and studious purpose there is to be found in his immediate environment a richness of experience and a depth of satisfaction which cannot be had in diffuse wanderings, however extended. "Only that travel is good," he claimed, "which reveals to me the value of home and enables me to enjoy it better."



OPENING OF THE RIVER CHANNEL; MASSACHUSETTS

Thoreau was always prompt to note the least promise of the coming spring, and the date when the first openings appeared in the ice of the river was duly recorded. The view in the photograph is looking upstream toward Fair Haven Hill.

WALDEN POND FROM THE SITE OF THOREAU'S HOUSE

Walden Pond, by the shore of which Thoreau built his famous cabin (memorialized by the cairn of stones in the foreground of the picture), has changed but little since his day and is still beautiful, both in winter and in summer.

ICICLE "ORGAN-PIPES"

The water from melting snow, trickling down over a perpendicular rock-face, freezes at night and "builds great organ-pipes of a ringed structure, which run together, buttressing the rock" (see page 179).

FROST CRYSTALS ON THE ICE

"They look like a loose web of small white feathers sprinkled from a tuft of down, as if a feather bed had been shaken over the ice. They are surprisingly perfect leaves, like ferns" (see page 175).

FANTASTIC SNOW-DRIFTS

In the ice of open stone walls, the wind, blowing through the chinks, carves the snow into many novel and picturesque forms. "This is the architecture of the snow."

Thoreau found such endless charm in the mystery and beauty of Concord fields and woods, so many fascinating problems requiring solution, such infinite variety in flower and bird and butterfly, such fresh delight in watching the progress of the seasons, as well as so much food for thought and inspiration in the human life around him, that he had no time for foreign travel. And for this he is sincerely grateful.

"I cannot but regard it," he says, "as a kindness in those who have the steering of me that, by the want of pecuniary wealth, I have been nailed down to this my native region so long and steadily, and made to study and love this spot of earth more and more. What would signify in comparison a thin and diffused love and knowledge of the whole earth instead, got by wandering?"

And there was a providence in this for others besides Thoreau. With his rare powers of observation, his innate sympathy with Nature, his keen sensitiveness to beauty wherever found, and his wonderful gift of verbal description, he has given us an unsurpassed picture of New England outdoor life which is destined to afford enjoyment and inspiration to thousands of people through all the years to come. It goes without saying that he never could have drawn this picture had he given much of his time to travel abroad.

Louisa Alcott, in her beautiful poem on "Thoreau's Flute," put the matter concisely:

> "Above man's aims his nature rose.
> The wisdom of a just content
> Made one small spot a continent,
> And tuned to poetry life's prose."

FOLLOWING THOREAU'S FOOTPATHS

It has been the writer's esteemed privilege during the past fifteen years and more to make many rambling trips to Concord, lured thither by Thoreau's vivid descriptions of Nature's beauty in his home surroundings. Without purposely attempting to repeat Thoreau's "travels," there has been found a peculiar pleasure in seeking out his favorite haunts, identifying places with which he was closely associated and which he named after a fashion of his own, and at the same time securing photographs of a great number of the actual scenes and phenomena in which he delighted.

These trips have been undertaken in all seasons of the year, coinciding so far as possible with Thoreau's own records and duplicating to a large degree many of his most enjoyable experiences. Especially has the winter season, which to many people is so burdensome and even repellant, proved wonderfully fruitful in subjects of interest and beauty.

DAYS OF NEW OPPORTUNITY

Thoreau was an enthusiast over the New England winter. He hailed its advent, noted every step of its progress, and found much of interest even in its lingering departure. At the close of the long, cold winter of 1855-56, with its record of ninety-nine consecutive days of sleighing in Concord—a period, one would think, long enough to upset the complacency of a man like Thoreau—he wrote, under date of April 10: "I look with more than respect, if not with regret, on its last dissolving traces."

There was something in winter's bareness and ruggedness, its simplicity and severity, its imperative challenge and its unexplored grandeur, which appealed irresistibly to his stalwart soul. And even stronger was the appeal to his esthetic sense. He never ceased to adore the spotless purity of the snow. Every snowstorm was a fresh revelation to him of Nature's inexhaustible beauty.

Days of intense cold were days of new opportunity to him. He was abroad in all kinds of weather, in all degrees of frost. The ice of the ponds and river he was diligent in exploring, both superficially and in its interior structure, and he was rewarded with exquisite displays of crystallization which very few people are ever privileged to see. Indeed, so extended and minute were his studies of winter's varying aspects that he could say on one occasion, as Emerson pleasantly relates, when returning a copy of Kane's "Arctic Explorations" which had been loaned to him, that "most of the phenomena noted might be observed in Concord!"

The winter climate of New England has been much reviled on account of its

A WINTER SUNSET FROM FAIR HAVEN HILL

On many a cold winter's day Thoreau would trudge a mile and a half through the snow to the top of this hill just to enjoy the sunset hour. "The man is blessed who every day is permitted to behold anything so pure and serene as the western sky at sunset."

XUM

EAST FROM NASHAWTUC HILL.

In pre-colonial times this hill was the residence of a famous Indian chief. Although of slight elevation, the views from its summit in all directions are very pleasing.

being so capricious. Sleet, slush, snow, hail, rain, freezing, thawing, blizzards, and sunshine make up a program which certainly does not lack in point of variety. Yet to this very fact is due much of the beauty of the New England winter. Were the cold uniform, did the snow which falls in December remain until April—conditions which obtain in certain other parts of the continent—the winter would lose a good part of its charm.

The winters in Concord today are just as changeful as in Thoreau's time, and one finds the same succession of varied phenomena which compelled his wonder and admiration.

WONDER IN THE WEAVING OF THE SNOW BLANKET

First of all, of course, there is the snow "blanket" enwrapping the earth, which to Thoreau was so suggestive both of utility and beauty—"a pure garment, as of white watered satin, over all the fields." There is wonderful fascination in the weaving of this blanket. The falling snow—what an incredible spectacle to one who has never seen it! And how the mystery and witchery of it persist even after one has seen it a thousand times!

To go abroad in Concord fields and woods during a snow storm is a memorable experience, especially if the snow is a little damp and clings to the trees and bushes in masses. Thoreau devotes many pages of enthusiastic description to a "lodging snow":

"The woods were incredibly fair, white as alabaster. Indeed, the young pines reminded you of the purest statuary, and the full-grown ones towering around affected you as if you stood in a titanic sculptor's studio, so purely and delicately white, transmitting the light. . . .

"Imagine the innumerable twigs and boughs of the forest crossing each other at every conceivable angle on every side, from the ground to thirty feet in height, with each its zigzag wall of snow four or five inches high, so innumerable at different distances one behind another that they completely close up the view, like a loose-woven downy screen."

And then, after the snow has fallen and the sun shines once more, the wind takes up the snow and whirls it into drifts, burying the fences and choking the highways. In the lee of open stone walls these drifts become curiously fantastic, the snow being carved by the wind, which whistles through the chinks in the wall into many novel and picturesque forms. "It builds up a fantastic wall behind the first—a snowy sierra. Astonishingly sharp and thin overhanging eaves it builds, even this dry snow, where it has the least suggestion from a wall or bank—less than a mason ever springs his brick from. This is the architecture of the snow."

With the coming of the sun, too, there appear those exquisite blue shadows on the snow. Given the right conditions of atmosphere and temperature, these shadows are captivating to every one who possesses the least sense of color values. What makes them so blue—"celestial blue"? "I think I never saw," says Thoreau, "a more Elysian blue than my shadow. I am turned into a tall blue Persian from my cap to my boots, such as no mortal can produce, with an amethystine hatchet in my hand. I am in raptures at my own shadow. What if the substance were of as ethereal a nature?"

READING THE SECRETS OF THE WILD

In his tramps afield after every fresh snowfall Thoreau took keen delight in reading the story of the wild life of the woods found in the tracks of fox and otter, squirrel and rabbit, crow and partridge, mouse and mink. The snow, he declared, is the great revealer, and he learned many secrets of the wild in these footprint studies.

Of all the denizens of the woods, however, Reynard held for him the greatest interest, and more than once he would spend a large portion of the day following the tracks of a fox and unraveling the record of its wanderings. Concord is so far from being wholly urbanized in these days that the wood-folk still linger within its precincts, and judging from the snowy tale of their gambols and journeyings they are scarcely less numerous than in Thoreau's time.

But Thoreau held that we may find in

AFTER AN ICE-STORM: MASSACHUSETTS

"Seen at the right angle, each ice-encrusted stubble shines like a prism with some color of the rainbow. What a crash of jewels as you walk!"

PINE FOLIAGE AFTER AN ICE-STORM

"The pines are as white as a counterpane, with raised embroidery and white tassels and fringes. Each fascicle of leaves or needles is held apart by an icy club surmounted by a little snowy or icy ball."

the snow the footprint of a life superior to anything of which zoölogy takes cognizance. "Why do the vast plains give us pleasure," he asks, "the twilight of the bent and half-buried woods? Is not all there consonant with virtue, justice, purity, courage, magnanimity? Are we not cheered by the sight? And does not all this amount to the track of a higher life than the otter's, a life which has not gone by and left a footprint merely, but is there with its beauty, its music, its perfume, its sweetness, to exhilarate and recreate us?

"Did this great snow come to reveal the track merely of some timorous hare, or of the Great Hare whose track no hunter has seen?"

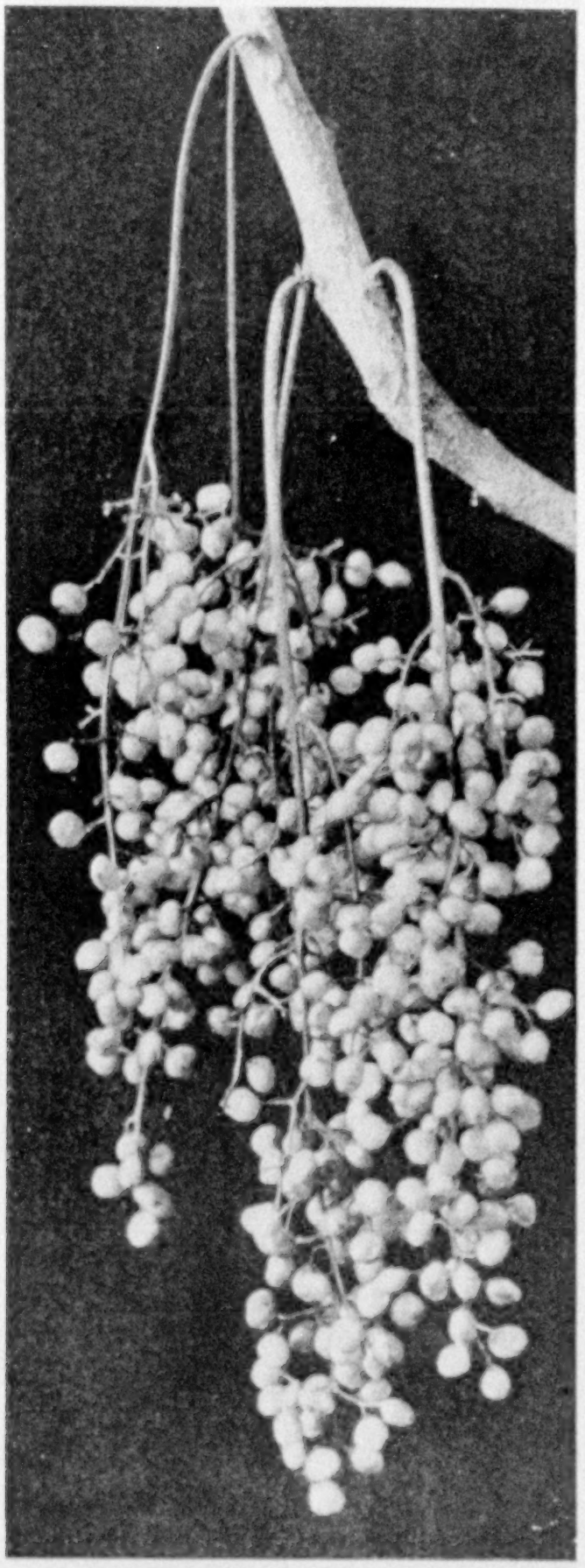
A SPECTACLE OF ENCHANTMENT

Apart from the phenomena of the snow, there occurs at rare intervals during the winter what Thoreau speaks of as a "frozen mist," when the trees and all other outdoor objects are covered in the early morning with a delicate hoar frost. This, of course, soon melts under the rays of the sun; but while it lingers the spectacle is one of enchantment.

"No snow has fallen, but, as it were, the vapor has been caught by the trees like a cobweb. The trees are bright, hoary forms, the ghosts of trees. Closely examined or at a distance, it is just like the sheaf-like forms of vegetation and the diverging crystals on the window-panes. You look up and behold the hugest pine, as tall as a steeple, all frosted over. Nature has now gone into her winter palace."

Akin to this phenomenon are the crystallized "rosettes," as Thoreau calls them, which are found sprinkling the surface of the ice after a night of severe cold. "They look like a loose web of small white feathers springing from a tuft of down, as if a feather bed had been shaken over the ice. They are, on a close examination, surprisingly perfect leaves, like ferns."

Frequently accompanying these feathery crystals, which are "so thin and fragile that they melt under your breath while looking closely at them," there is another form of needle-shaped crystals in bun-



POISON-DOGWOOD BERRIES: MASSACHUSETTS

Thoreau has numerous references in his winter notes to the novelty and beauty of the fruit of the poison-dogwood, which hangs in clustered panicles from the leafless stems of the shrub.

FOX TRACKS IN THE SNOW: MASSACHUSETTS

Thoreau took keen delight in reading the story of wild life in the woods as shown by the tracks in the snow, especially those of the fox. The foreground of the picture shows where the fox was digging for mice.

dles, or "as if oats had been spilled, like fibers of asbestos rolled." Both forms, he thinks, result from vapor congealing as it finds its way through interstices in the ice, and both are uniquely beautiful.

TRACKS OF A HARE

"Did this great snow come to reveal the track merely of some timorous hare, or of the Great Hare, whose track no hunter has seen?"

THE ICE-STORM

Rarest and most beautiful of all, however, are the phenomena attendant upon an "ice-storm"—something which does not occur every winter. In fact, it was only after several years of patient waiting that the writer was able to secure photographs illustrating this striking event.

The necessary conditions are: a gently falling rain, a stratum of air next the earth with temperature below the freezing point, and this overlaid with warmer strata from which the rain proceeds. Thus the rain freezes as fast as it falls, and there is gradually built up around every object a coating of ice. Then, when the sun comes out, the whole world is turned into a veritable crystal palace.

"All objects, even the apple trees and the rails, are to the eye polished silver. It is a perfect land of fairy.

"Seen at the right angle, each ice-encrusted stubble shines like a prism with some color of the rainbow—intense blue, or violet, and red.

"What a crash of jewels, as you walk!

"The fine spray of a myriad of bushes on the edge of the bank sparkles like silver.

"The drooping birches along the edges of the woods are the most feathery, fairy-like ostrich plumes of the trees. The pines are as white as a counterpane, with raised embroidery and white tassels and fringes. Each fascicle of leaves or needles is held apart by an icy club surmounted by a little snowy or icy ball. Finer than the Saxon arch is this path running under the pines, roofed, not with crossing boughs, but drooping ice-covered twigs in irregular confusion.

"God exhibits himself to the walker in a frosted bush today, as much as in a burning one to Moses of old."

Thus, for page after page, Thoreau attempts to convey some idea of the beauty of this icy wonderland. But no words

A FROSTY MORNING: MASSACHUSETTS

Occasionally during the winter there occurs what Thoreau speaks of as a "frozen mist," when the trees and all other outdoor objects are covered in the early morning with a delicate hoar-frost.

THE SNOW RECORD

From left to right: 1. Tracks of a pheasant retreating hastily. 2. The same pheasant approaching cautiously from cover. 3. Tracks of a rabbit, also probably alarmed. 4. Tracks of a partridge. Tracks of a fox coursing along the edge of the swamp are also discernible.

and no photograph can do more than merely hint at the reality. Whoever has once witnessed the phenomenon of a New England ice-storm can never forget its ravishing beauty.

THE ORGAN-PIPES OF ICE

Another icy spectacle which Thoreau always took pains to observe on its annual recurrence was the formation of icicle "organ-pipes" on the face of a certain cliff in Concord, and one can find the same process in operation, under suitable conditions, in exactly the same spot today. The water from melting snow trickles down over the perpendicular rock-face, and "its constant drip at night builds great organ-pipes of a ringed structure, which run together, buttressing the rock.

"Behind these perpendicular pipes, or congregated pillars, or colonnades run together are formed the prettiest little aisles or triangular alcoves with lichen-clad sides. The shadow of the water flowing or pulsating behind this transparent icy crust or these stalactites in the sun imparts a semblance of life to the whole."

This suggestion of life, by the way, was always a most welcome feature of Thoreau's winter walks. Any reminder of the past summer, such as a bird's nest with its "snowy egg," or the persistent panicles of poison-dogwood berries, "beautiful as Satan," or the scarlet fruit of the black alder, gave him keen pleasure.

Likewise the least promise of the coming spring, like the opening of the river channel, or the breaking up of the ice in the ponds, or a distant bluebird's warble. Even so simple a thing as a running brook called forth his enthusiasm. "Perhaps what most moves us in winter," he wrote, "is some reminiscence of far-off summer. How we leap by the side of the open brooks! What beauty in the running brooks! What life! What society! The cold is merely superficial; it is summer still at the core, far, far within."

INTERPRETING THE "GRAND OLD POEM WINTER" EVERYWHERE

Thoreau made all his observations of winter phenomena in Concord, but it by no means follows that one need make a

A BIRD'S NEST WITH ITS "SNOWY EGG"

During his winter walks Thoreau always took keen delight in discovering any reminder of the past summer, even if it was only a deserted bird's nest filled with snow.

journey to Concord to witness and enjoy the same phenomena. All through the northern portion of the United States, except upon the Pacific coast, there is annually staged upon the platform of winter the same drama of wonder and beauty which so aroused his admiration.

Indeed, in certain sections there sometimes occur spectacular effects of which Thoreau never witnessed anything more than the merest suggestion, such as the brilliant "sun-dogs," "inverted rainbows," and kindred atmospheric phenomena which frequently accompany days of intense cold in Minnesota and North Dakota. Also, in connection with many of the higher waterfalls of the northern States, there are superb displays of frost magic, such as that which annually draws a throng of visitors to Niagara, far transcending in magnitude and beauty anything which Thoreau ever saw on his winter visits to the tiny waterfalls of Concord.

But the ordinary aspects of winter, so familiar to all who dwell in regions periodically visited by the Ice King, Thoreau has made the subject of graphic description. The snow crystals falling upon his coat sleeve, the icy fretwork on the puddle by the roadside, the "booming" of the pond on cold evenings, the snow-encased pump, the farmer piloting his ox-sled through the drifts, the lisping of chickadees among the snow-laden hemlocks, the fisherman with his string of pickerel caught through the ice, the close-wrapped buds of trees and shrubs, the humming of the telegraph "harp," the snow-buntings and tree-sparrows—"true spirits of the snowstorm," the red alder catkins "switching in the face of winter and bragging for all creation," the woodchopper and his noonday lunch, the scream of the blue-jay—"a sort of wintry trumpet," the snow-fleas in the wheel-ruts, the frost-tracery on the window pane—all these and many other incidents and phenomena of the winter are faithfully and lovingly recorded.

Trivial matters? Yes, and yet they are so charmingly treated in Thoreau's interpretation of "that grand old poem called winter" that we forget their trivial and commonplace character and are made to see how much they contribute toward the beauty and the harmony of the whole.

NEW PICTURES PAINTED AT EACH SUNSET

There is one very common phenomenon of the winter time—a daily occurrence, in fact—which Thoreau dwells upon with marked frequency and always in a mood of special exaltation. To him, in all seasons of the year, the holiest hour of the day was the hour of the setting sun, and in the winter season its appeal was most potent.

Under date of January 7, 1852, he wrote: "I go forth each afternoon and look into the west a quarter of an hour before sunset, with fresh curiosity, to see what new picture will be painted there, what new panorama exhibited, what new dissolving views. Can Washington Street or Broadway show anything as good? Every day a new picture is painted and framed, held up for half an hour, in such lights as the Great Artist chooses, and then withdrawn, and the curtain falls."

WHERE THE WORLD GETS ITS OIL

But Where Will Our Children Get It When American Wells Cease to Flow?

By George Otis Smith

Director United States Geological Survey

IN THE course of the centuries the raw-material issue changes. In the long-bow epoch of England's military strength the conservationist feared a depletion of the yew wood which might give the Teuton, backed up by his larger forests, an obvious advantage in light ordnance. Later, when Great Britain's naval power depended upon her wooden ships of war, the anxious naval chief foresaw a possible shortage of the oak which made the walls that stood between England and her enemies.

The yew and the oak are no longer essential to national defense, for steel has proved the substitute in both arms and armor plate. Yet today those who plan for the future prosperity of their nation realize the extent to which other raw materials are essential to the general well-being, and for some of these we can see no adequate substitutes.

Foremost among these most useful and least abundant, if not, indeed, irreplaceable, commodities stands mineral oil, or petroleum, and not only the conservative Briton, but the most optimistic American, may well ask himself, Where will my children and children's children get the oil that they may need in ever-increasing amounts?

THE WORLD'S GREATEST OIL PRODUCER AND CONSUMER

The leadership of the United States as an oil producer and consumer is spectacular enough to satisfy our American love of doing things on a big scale. For sixty years, except in 1898 to 1901, when Russia reached the peak of its past petroleum production, the United States has led the rest of the world with its steadily increasing flow of oil.

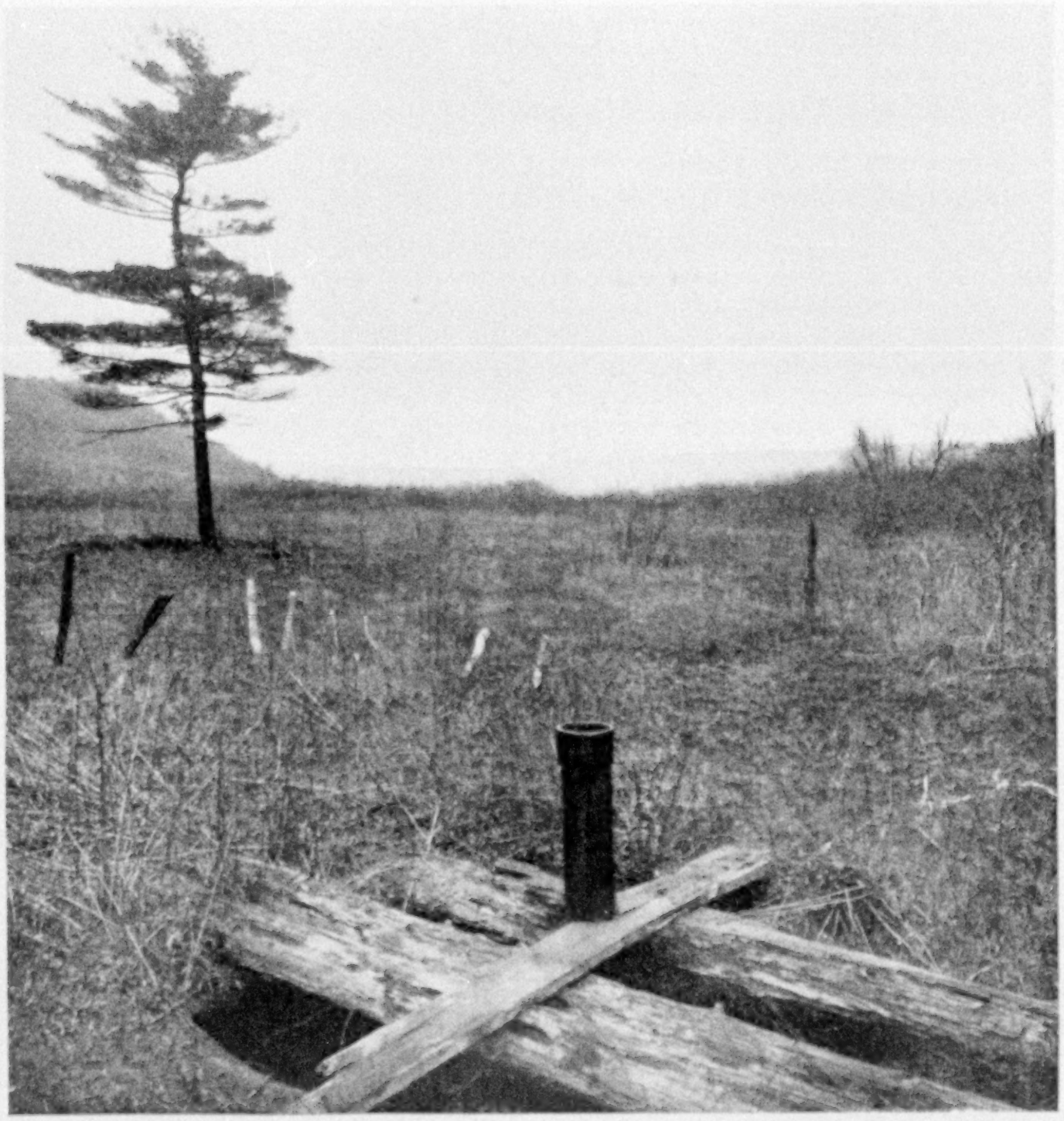
But while we have contributed far more than half (61 per cent) of the oil that the world has used in all these years, we have already reached the point where we are consuming more oil than we produce. Is this position of the world's greatest user of petroleum as safe as it is spectacular?

The story of the petroleum industry in the United States extends back only sixty years. On August 28, 1859, oil was struck in the Drake well, near Titusville, in northwestern Pennsylvania, and when the pumping began the oil flowed in a tiny stream of 40, and later only 15, barrels a day; but since that day of small things the tide of oil has mounted higher and higher: 5 million barrels were produced in 1870, 26 million in 1880, 45 million in 1890, 63 million in 1900, 209 million in 1910, and 356 million barrels in 1918, with the output last year perhaps 20, or even 30, million barrels in excess of that record. The crest of this flood of oil must surely soon be reached.

A NIAGARA OF OIL

We are the world's greatest consumers of petroleum; but, impressive as are the 1918 figures of consumption — 413,077,113 barrels—no mind can easily grasp the idea of that quantity. Truly it is a flood of oil; for, if spread over the 60 square miles of the District of Columbia, these 413 million barrels would cover the area to a depth of nearly a foot and a half.

Or perhaps the eye can better visualize the torrent of oil that flows each year from the 203,400 wells, is pumped through the long pipe lines, and is brought up from Mexico in huge tankers, if we figure that a year's supply of oil equals the flow of the waters from the Great Lakes and their vast drainage basin over Niagara Falls for three hours and four minutes; or, in terms of the



Photograph from Dr. D. T. Day

THE SITE OF AMERICA'S PIONEER OIL WELL

A new chapter in industrial history began sixty years ago with the flow of petroleum from this 69-foot bore-hole on Oil Creek, Pennsylvania. Edwin L. Drake did not strike it rich, receiving only an annuity from the Keystone State and a monument from the industry he founded.

smaller stream flowing past the Nation's Capital, if the Potomac at Great Falls were a river of crude oil, the nation's annual requirements could be met only with the flow at the summer rate for nearly four days and a half.

So it is that while in 1918 our "home fires" in power plant, blast furnace, locomotive, and residence consumed a mountain of coal a mile and a third in diameter and nearly 2,000 feet high, we also used a river of oil.

Credit is often due to the silent partner in a business, and the marvelous growth of our oil industry owes much to its own transportation system, unseen and unknown by most citizens, yet far more efficient than the railroad lines of which we are so proud.

Beginning with four miles of iron pipe

A SKETCH MAP SHOWING THE ELABORATE OIL PIPE-LINE SYSTEM WHICH FORMS A NETWORK BENEATH THE SURFACE OF THE EASTERN HALF OF THE UNITED STATES

There are enough oil pipe lines in the United States to girdle the earth at the equator and have 5,000 miles to spare.

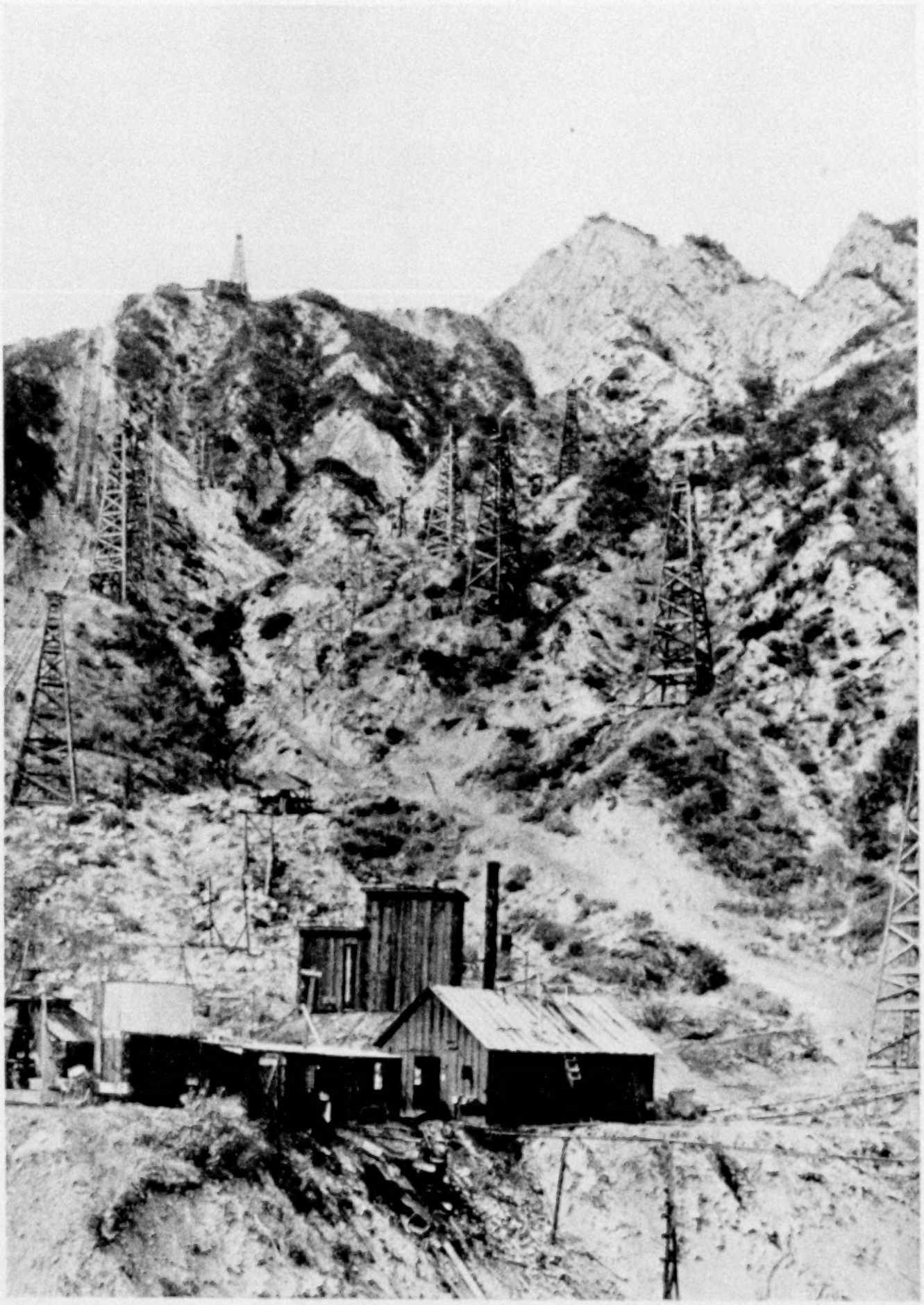
laid down in western Pennsylvania at the close of the Civil War, this system now embraces a huge network of buried pipes from four to eight inches in diameter, trunk lines and laterals, aggregating nearly 30,000 miles (see map above).

A VAST NETWORK OF OIL PIPE LINES

Along these hidden transportation lines there are pumping stations every 40 miles or so, but the daily circulation of oil in these long arteries is appreciated only by the oil operators who sell their product at one end and the refiners or shippers who receive it at the other end.

Another measure of this pipe-line system is given in the fact that it would take approximately two days' flow from the 200,000 wells of the country simply to fill these pipes.

Petroleum's rank among the minerals is won not by attractive appearance, but by sheer usefulness. Few of us fully appreciate how essential this mineral oil is in



Photograph from U. S. Geological Survey

OIL WELLS IN VENTURA COUNTY, CALIFORNIA

The topography and the locality suggest "nothing venture, nothing have," which is one of the rules in hunting oil.

Photograph from U. S. Geological Survey

NUMBER FOUR WELL AT JOY FARM, OHIO, DRILLED IN 1864 AND STILL PRODUCING OIL

the world economy or realize all the changes that have come about in its use within a decade or two.

OIL NO LONGER OUR LIGHT BY NIGHT, BUT PREMIER POWER SOURCE

When most of us were in school, "oil" meant kerosene, and gasoline or benzine was something to be bought in a bottle at the drug-store or the paint shop. In those earlier days the oil refiner put as much gasoline in his kerosene product as the traffic would allow; today the automobilist complains that his gasoline contains too much kerosene. The refiner simply robs his less marketable kerosene of the more inflammable content; so that, as has been suggested, if Widow O'Leary's cow again kicked over the lamp, in all probability the spilt oil would not set Chicago or any other city on fire.

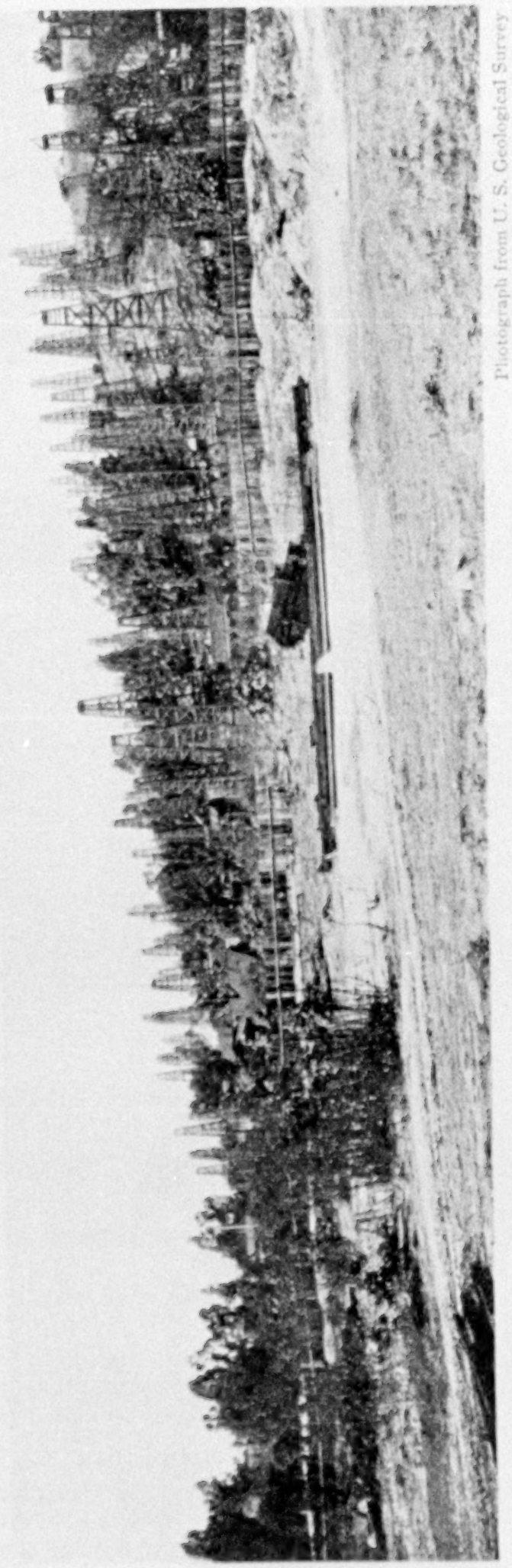
In those earlier days, too, fuel oil played no part in industry. Then, petroleum's future mission seemed to be to light up the dark corners of the world—to be the handmaiden of Minerva; today, oil has become the premier motive power, not only on land and sea, but even in the heavens above and the depths below—truly the best servant of Mars and Mercury.

Marshal Foch is quoted as saying that "a drop of gasoline was worth in war a drop of blood," and M. Bérenger, the French Commissioner-General of Petroleum, expressed the same idea when he called attention to the fact that victory on the battlefields of Belgium, France, and Italy "could not have been gained without that other blood of the earth which is called oil."

"And if petroleum has been the life blood of the war, it will be still more *the life-blood of peace.*" The strategy of peace should, however, lead us so to plan for wise use of this precious fluid that Mother Earth will not too soon be "bled white."

MORE THAN 300 PRODUCTS OF PETROLEUM

The number and variety of uses of petroleum and its products are continually increasing, but even more striking is our increased dependence upon a few of the products of the oil refinery, notably gaso-



Photograph from U. S. Geological Survey

A GLIMPSE OF A SOUTHERN CALIFORNIA OIL FIELD

A forest of derricks, where many wells did the work of a few, thus illustrating the waste of capital and labor under conditions of competitive drilling.

line, kerosene, the many types of lubricating oils, and fuel oil.

There are said to be 300 or more products of petroleum, each with its own use. Some of these products serve merely our convenience, such as the artificial "vanilla" flavoring or the cover of paraffine on the jar of jelly or marmalade; others were found during the war period to be absolutely essential to industry on a large scale—for example, the heavy oil used in tempering steel plates.

One picture of the demand for the principal petroleum products can be seen in a recent statement of United States Army peace-time requirements, which included 74 million gallons of fuel oil, 11 million gallons of gasoline, two million gallons each of lubricating oil and grease, and one million gallons of kerosene. Not only will the size of this single order open some eyes, but its make-up is significant and disconcerting.

Taking the figures of the Bureau of Mines on refinery production last year, we find that the output of gasoline was not quite double that of kerosene, and the output of lubricants was less than half that of kerosene, and here the army wants eleven times as much gasoline as kerosene, and twice as much lubricating oil. The discord between demand and supply in this one order is even worse for fuel oil, of which the output last year was about five times that of kerosene; and yet the army wants 74 times as much.

LUBRICANTS ARE THE BAROMETER OF BUSINESS

Too broad an inference from any one set of figures is unwise, but other statistics point in the same direction: Fuel oil is used on 357 vessels of our navy, and the Shipping Board has an-

From "World Atlas of Commercial Geology," U. S. Geological Survey

MAP SHOWING PRODUCTION OF PETROLEUM IN THE UNITED STATES IN 1918, AND THE OUTLINES OF THE PETROLEUM AREAS

Each black dot represents one per cent of the total production of petroleum in the United States. The dotted lines surround oil-producing areas. Where the production is less than one per cent, the area is indicated by the cross.

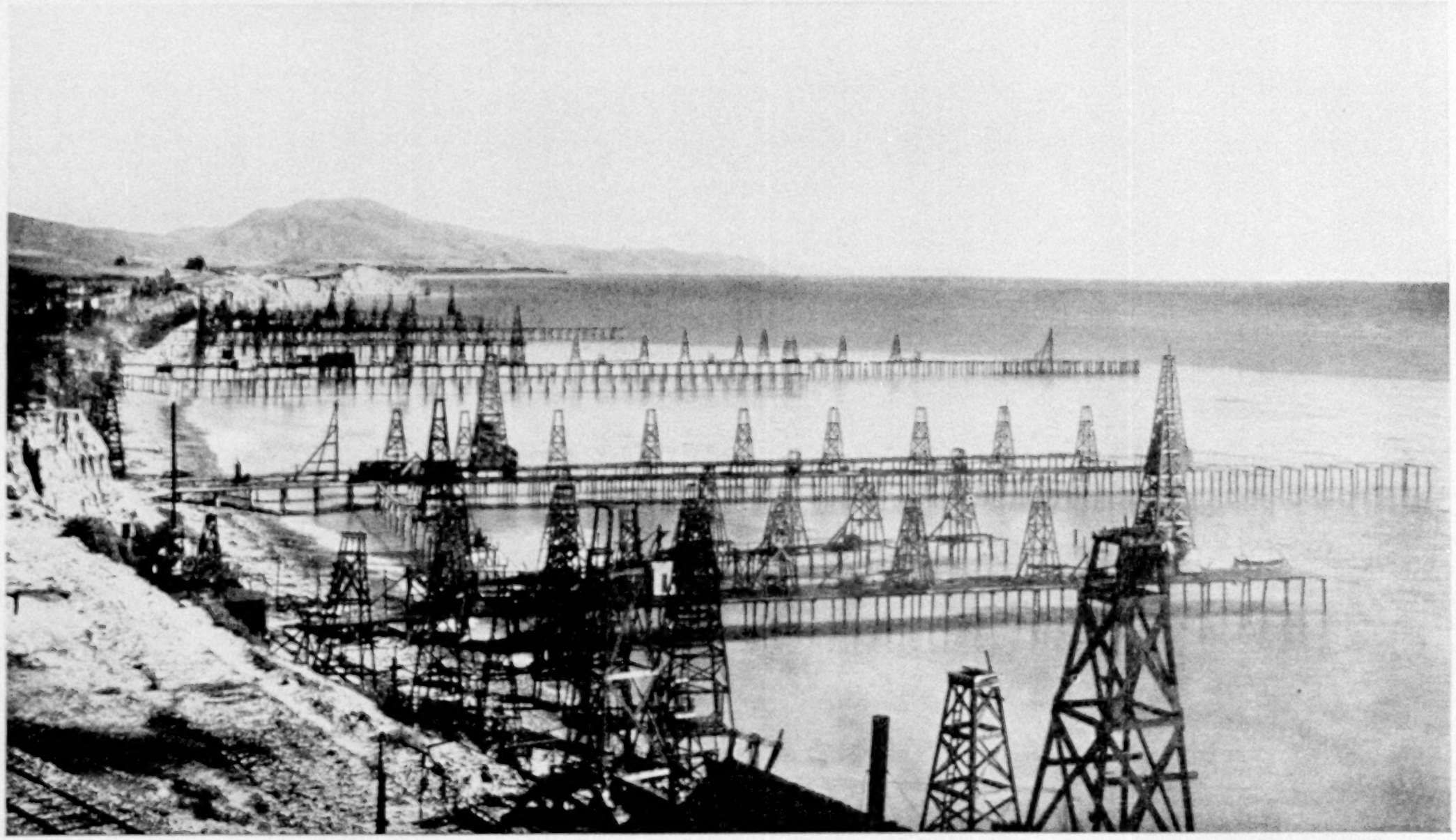
nounced that there will soon be 1,731 oil-burning vessels of the merchant marine under the American flag; gasoline is now sold at every cross-roads, and we know that the use of this fuel in automotive engines has more than quadrupled during the present decade; and the country's demand for lubricating oil, which is an essential in every phase of modern civilization, increases so rapidly that we must agree with the Bureau of Mines in the belief that the current consumption of lubricants is an excellent barometer of business and industrial conditions.

SIX MILLION PLEASURE CARS IN THE UNITED STATES

Inventive genius and economic necessity may from time to time change the relative demands for this or that petroleum derivative, but the sum total of these demands must increase as the number of swiftly turning wheels in the world increases.

It is when we think of the marvelous growth of the automotive industry that we realize a future demand for lubrication that staggers even the prophetic statistician. With more than six million pleasure automobiles operated in the United States alone, we have an annual consumption estimated, by the officials of the foremost company manufacturing high-grade lubricants, at 120 million gallons of lubricating oil, where twenty years ago the demand for this purpose was practically nothing.

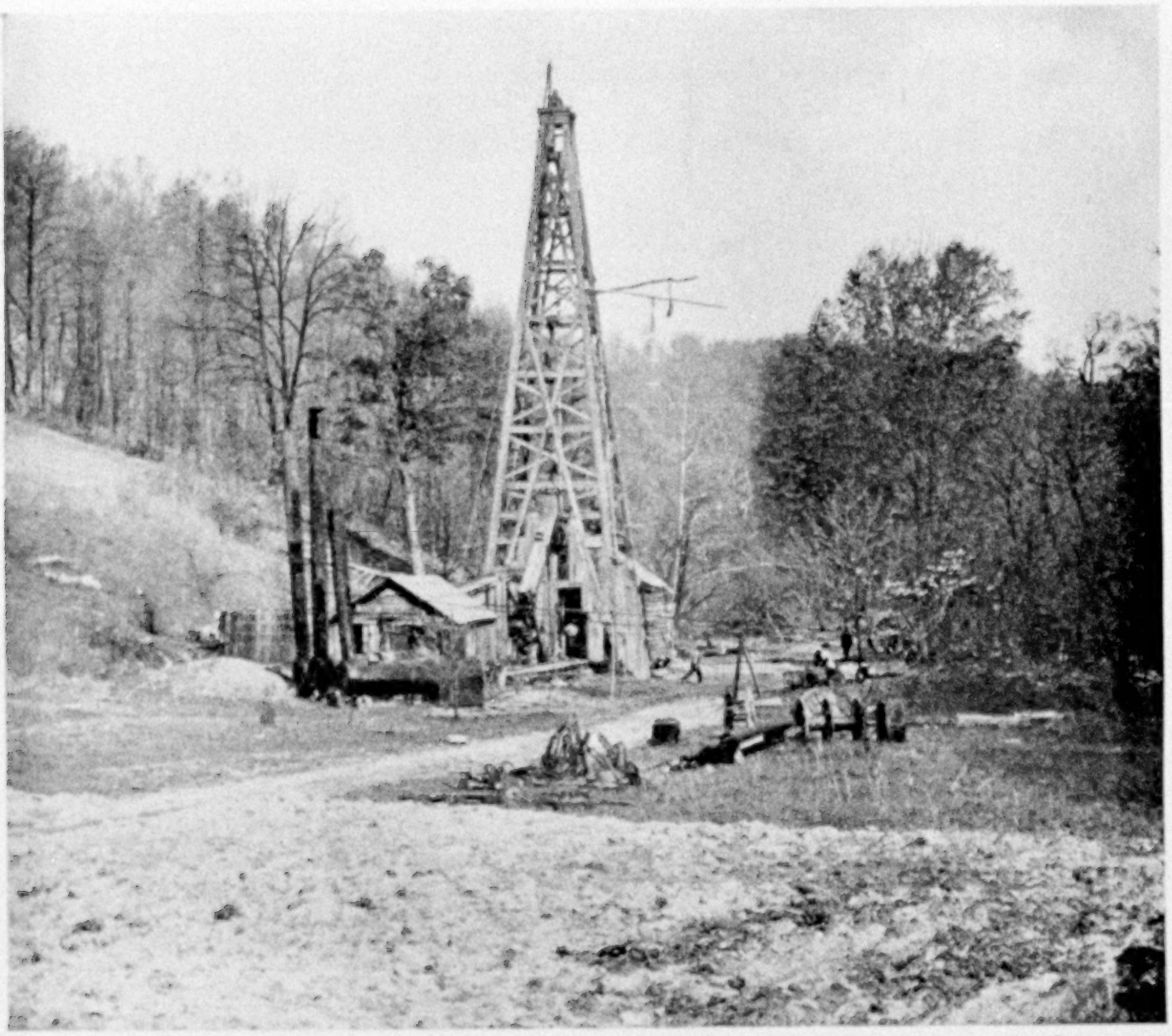
Moreover, today a fleet of half a million motor trucks travel up and down our city streets and State roads, delivering every kind of commodity from eggs to pianos, and these powerful motors furnish a market for 37½ million gallons of lubricating oil. But while we may expect the demand for oil by automobiles to continue to increase rapidly and the requirement by trucks may possibly double within a few years—indeed, a tire company estimates that even now a million trucks are in service—who can even guess at the number of tractors that may be operating on our farms within



Photograph from U. S. Geological Survey

THE SUMMERLAND FIELD IN SANTA BARBARA COUNTY, CALIFORNIA

Where man's conquest of the subterranean treasure extends beyond the shore-line. These wells were drilled 300 feet below sea-level to reach the oil.



Photograph from Hope Natural Gas Company

THE DEEPEST HOLE IN THE WORLD

America leads in courage and skill in exploring the earth's crust in the search for oil and gas. The Lake No. 1 well in West Virginia had reached a depth of 7,589 feet, or 240 feet deeper than the deepest well in Europe, when the steel cable parted nearly three-fourths of a mile below the surface. This is the second world record established by the Hope Natural Gas Company, the Goff well being 7,386 feet deep, but neither of these West Virginia wells has yielded anything but facts for the geologist.

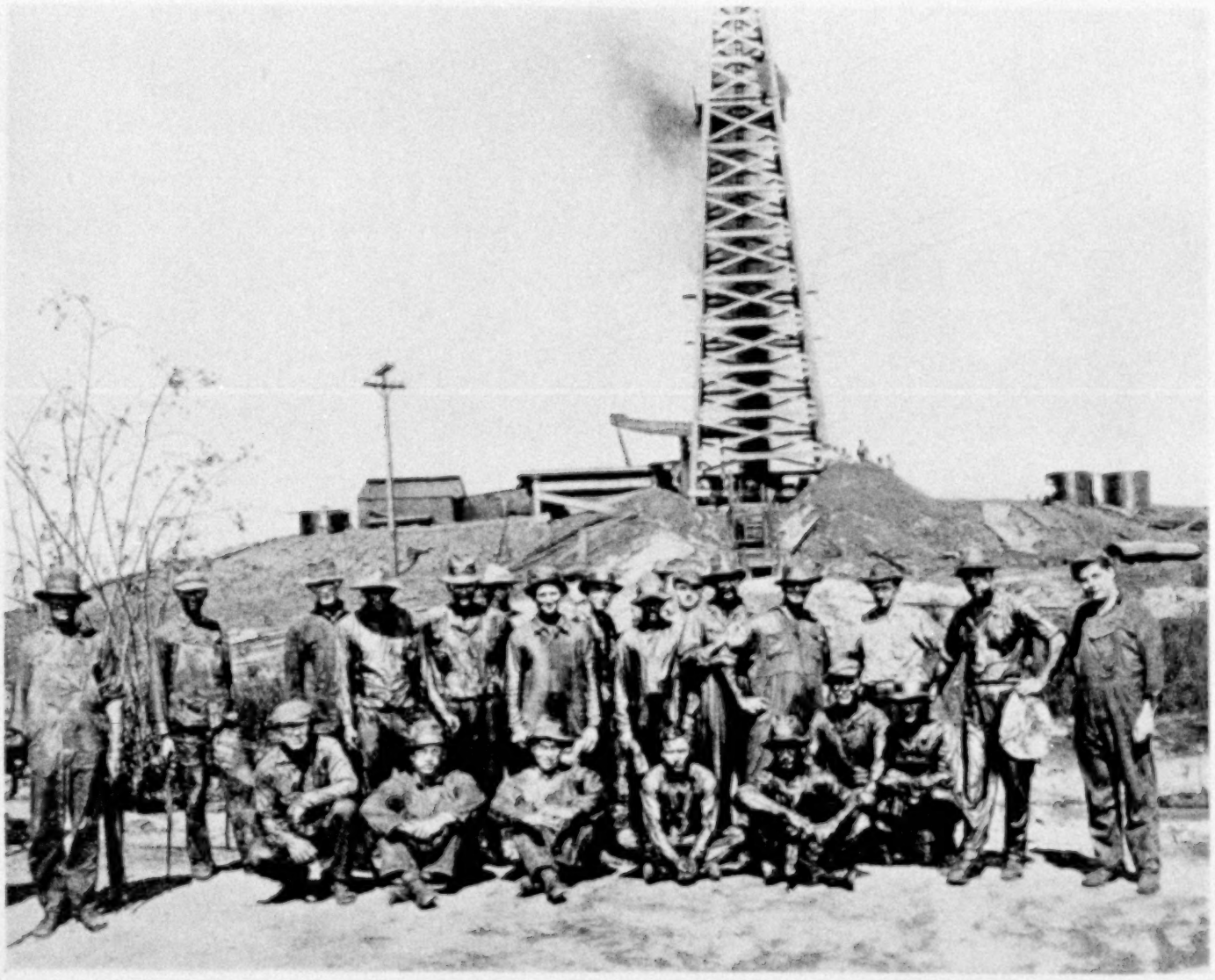
the next five years? Already the number of tractors in operation is estimated as a third of a million, and they consume about 35 million gallons of lubricating oil.

We have, then, a total of fully 200 million gallons of lubricating oil already required to keep the automotive equipment of our country running smoothly, and we must not shut our eyes to the fact that millions and millions of gallons more will be needed each year.

HOW OIL SAVES POWER

The steady growth of industrial America is observed by all, but we need the help of census statistics to realize the rate of that growth. The power used in our manufacturing has about doubled in the past sixteen years; the kilowatt-hours turned out by our public-utility stations have increased eight or nine fold in that same period. Indeed, the single State of New York will use far more electric power this year than the whole country did in 1902.

And so the demand for lubricants becomes stronger on the road, on the farm, and in the mill. Still, while we think of this rapid development of power as using increased amounts of oil, it is equally true that oil saves power; so that if ma-



Photograph from D. A. McDannald, Orange, Calif.

THE WONDER-WORKERS

Drillers whose skill taps the oil-sands half a mile or more beneath the surface.

chinery multiplies man-power, lubricating oil is a good and faithful servant that deserves more than a passing thought.

With all these demands for fuel and lubricants, who can venture an estimate of our needs even ten years hence? Whence will the petroleum come to meet these needs? That river of oil representing our 1918 consumption drew from the ground more than one-twentieth of the quantity estimated by the United States Geological Survey geologists as the content of our unrecovered underground reserve, and it also took nearly one-fifth of the oil stored above ground.

The estimate of about 6½ billion barrels as now available is far less impressive when we realize how fast we are using it up and that while we have burned and wasted less than 1 per cent of the coal resources of the United States in the last 100 years we have apparently used up 40 per cent of our available oil supply in only 60 years.

This is why the hunt for oil has become world-wide and suggests a compelling reason for Americans to lead in that hunt.

A HUNTER WHOSE WEAPON IS THE DRILL

The geologist has lately come into his own as a money-saver in the employ of oil companies. Today not less than 750 geologists are in the employ of corporations, large and small, selecting the most promising fields for oil exploration and sites for new oil wells. Where it costs from $8 to $20 a foot to drill a well and the oil sands are 3,000 to 4,500 feet beneath the surface, as in California; or 450 to 3,600 feet, as in Oklahoma; or possibly as much as 3,600 feet, as in the

Photograph from Mining Review, Los Angeles

THE LAKEVIEW "GUSHER" OF CALIFORNIA

In its day a record-breaker, but not comparable to the Mexican "gushers." The spectators on the sand-bag embankment later discovered their linen to be spotted with oil-mist.

new Ranger field in Texas, the expense attending the drilling of a single well is something to be considered in the economy of the business, especially when, as the Bureau of Mines states, oil wells, like everything else, cost about twice as much as they did before the war.

The geologist simply applies his science to the problem of making as many wells as possible successful and of preventing drilling where oil cannot be found. Every "dry hole" is, in the last analysis, a tax on the consumer, that patient Atlas of the world's ever-mounting load of high costs.

A recent study of the results of extensive geologic examinations on the Osage Indian lands shows conclusively that in this region, which rather favors the Government geologist in his effort to locate oil, his geology was right 87 per cent of the time, when tested by the drill. Business can ask of science no better percentage of success than that, and the money and labor and supplies that can thus be saved to the nation constitute no small item.

A BIG LEAK—THE STOCK PROMOTION GAME

One of the leaks in the nation's task of finding oil is nearer home to many of us. The stock-promotion game attracts too many dollars to no useful purpose.

It has been stated that two years ago these much-advertised oil companies, with more assets on paper than on the ground or under the ground, were to be credited with a very small fraction of 1 per cent of the oil yield of Oklahoma; indeed, the issue of stock certificates reached the point where for every $555 of ill-advised investment only one dollar's worth of oil was produced. Thus does the combination of unscrupulous stock-peddler and ignorant investor undo much that the conscientious oil-producer is striving to accomplish in getting the most oil out of the ground at lowest cost.

XUM

Photograph from Bureau of Mines

A "TANK" FARM

Where one of the group of huge storage tanks has been set on fire by lightning. In our automobiles we also use the electric spark for ignition, but to better purpose.

Conservation touches petroleum at many points. There is need for a country-wide thrift campaign looking to the saving of this essential resource. Man-power and oil ought to be conserved at all stages of production and consumption by better methods in the discovery, drilling, recovery, transportation, refining, and use of petroleum and its products.

The price of crude oil has just reached a new level, and eventually this must influence the price of the refinery products, a fact that ought to give impetus to thrift among users of every petroleum product.

WHERE THE WASTE BEGINS

Unwarranted optimism, which seems indigenous in most parts of the United States, has led both the oil industry and the public to waste this best of fuels. The program of wastage begins below the ground with only partial recovery, goes on above the ground with leakage and evaporation, and continues all along the line to the indiscriminate burning of fuel oil under boilers with regard for convenience rather than for efficiency, or to the even less defensible use of petroleum for oiling our roads.

In oil-field operation, in refinery practice, and in the use of oil everywhere, too often the dollar test of economy is the only one applied. The situation, however, is critical enough to demand another rule—that of taking thought of the morrow and of weighing the questions of ultimate supply and demand.

But, with those early forest conservationists of old England in mind, the question may be asked, Are there no practical substitutes or other adequate sources? The obvious answer is in terms of present prices; the real answer is in terms of cost in man-power.

THE ADVANTAGES OF OIL OVER COAL

Whether on land or sea, fuel oil is preferred to coal because it requires less

© Underwood & Underwood

WORKING NEAR THE FIRING-LINE

The lineman repairing wires close to the huge oil tank, which the firemen are trying to keep below the explosion temperature. This $2,000,000 fire on Long Island caused the greatest call for fire apparatus that New York City has ever known.

bunker space and fewer firemen; and, back of that, in the man-power required in its mining, preparation, and transportation, the advantage on the side of oil is even greater. So, too, the substitute for gasoline in internal-combustion engines, whether alcohol or benzol, means higher cost and larger expenditure of labor in its production. Moreover, for alcohol agricultural land would be required, and for benzol in the quantities needed a far greater coal consumption than is now necessary.

Again, while we fortunately have our great reserve of oil shales as an independent source at some future date, we do well to consider the practical contingency suggested by Mr. Requa, that to develop this source on a scale comparable in output with our present oil supply "would require an industrial organization greater than our entire coal mining organization." Plainly, our country can not afford to support another such army of workers until we reach another stage in our industrial development.

The question of safeguarding America's oil supply has been prominently before the American people for more than ten years. In September, 1909, President

Photograph from Bureau of Mines

AN OIL TANK SET ON FIRE BY LIGHTNING

A pillar of smoke by day that represents a total loss to the world that needs oil.

Taft ordered that all public lands believed to contain petroleum should be reserved from disposition until a law could be passed that might assure an adequate supply of fuel oil and lubricating oil for our navy and in some degree check the wasteful overproduction in the rich oil fields of California. Such a law is now under consideration by the conference committee of the two Houses of Congress.

WHERE WE SHALL GET OUR OIL IN FUTURE

Ten years is a long period for these "temporary" withdrawals to run pending the enactment of suitable legislation, and in that time the country's need of oil, as measured by its consumption, has doubled. If in 1909 our Chief Executive had reason to plan the safe and sane disposal of the petroleum still in public ownership, in 1920 we surely need to look even further and see if possible where our children will get the oil they will require in increased amount.

Photograph from M. L. Alexander

ENGINEERING EXPERTS BRINGING UNDER CONTROL A "WILD WELL" IN LOUISIANA

On the accompanying map of the world (see page 200), are indicated the regions from which, according to present information, the oil supplies of the future are to be drawn.

The diagrammatic representation of the relative abundance of the oil resources in the ground in different countries is at best highly speculative. Most of the other countries outside of Europe have not been covered so thoroughly by geologic examinations as the United States. In fact, some of the oldest and most highly civilized countries have not been studied by geologists specially trained in the geology of oil and gas, as is shown by the fact that it remained for an American expert to bring to the attention of the British the probabilities of the occurrence of oil fields in old England itself.

A glance at the map shows that outside of the United States the great oil supplies of the future, so far as now known, are centralized mainly in the Near East, in South America, and in Mexico. According to reports, there may be great reserves of oil in Africa, and it is also possible that eventually considerable supplies may be discovered in the Far East.

In general, the regions developed first and drawn on most heavily are, of course, likely to be soonest exhausted. Therefore it is practically certain that, as the oil resources of the United States and Rumania diminish and the reserves of Mexico also yield under the pressure of rapidly increasing exploitation, the world

Photograph from Mexican Petroleum Co.

THE WORLD'S GREATEST OIL WELL.

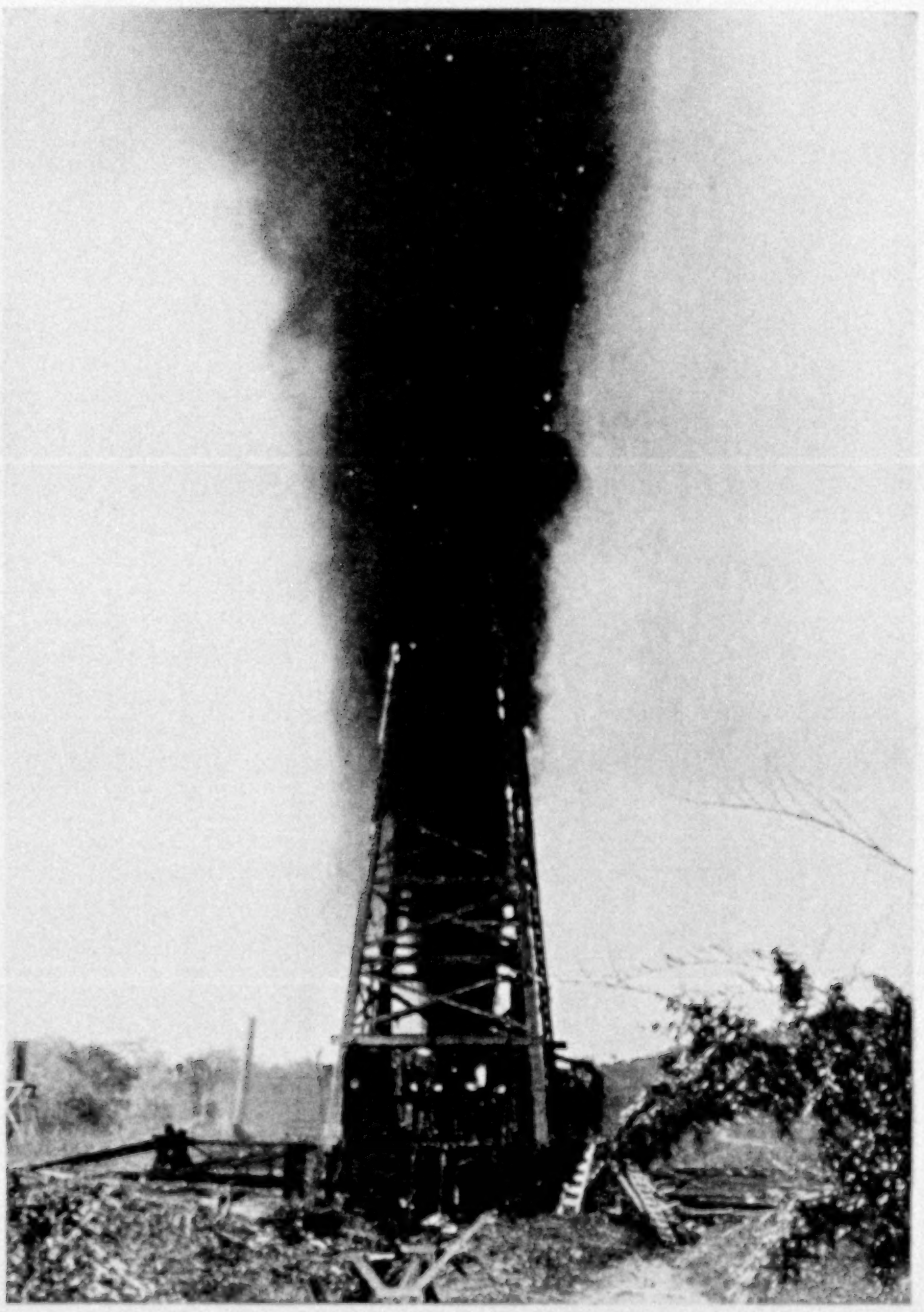
A well in Mexico named Cerro Azul No. 4 shot a column of oil higher than our Washington Monument and drenched the country with a rain of oil for two miles around. Engineer measurements showed the column to be 600 feet high and the flow to have been more than a million barrels in the week before man harnessed this great force.

will have to look for its oil supplies to those regions where inaccessibilities and lack of demand, due to the social and industrial backwardness of the peoples, have hitherto retarded exploration and production.

HOW MEXICO'S OIL HAS BEEN EXPLOITED

The rapidity with which a region of relatively recent development may be exploited is illustrated in Mexico, whose petroleum output has risen since 1910 until it is second only to the United States, having doubled in the last five years. Mexico has been a land of oil-gushers and big wells, and with less than 300 producing wells the potential daily production has been estimated as about one and a half million barrels, but the actual output is not much more than 10 per cent of that.

The increases in production in the United States and Mexico for the year 1918, as compared with 1917, are respectively twenty million and eight million barrels. This shows how large a responsibility for the world's oil supply Mexico is already assuming.



Photograph from Mexican Petroleum Co.

THE CERRO AZUL NO. 4 IN FULL FORCE

The great volume of gas and oil completely wrecked the derrick, and in the first blast of gas threw the 2-ton drill-bit high in the air, landing 125 feet from the well and within three yards of a "movie" photographer. Photographing a wild well is not without discomfort and danger.

What is to happen when, following the United States, Mexico must reduce her output with the progressive exhaustion of her oil resources, and what are to be the competitive conditions in the United States when the other great nations of the world, whose use of petroleum is now relatively insignificant, awaken to the realization of the unique and almost priceless advantages of this great natural resource?

The United States, though the largest producer and consumer of oil, has given too little heed to the future; Great Britain, almost the smallest producer, has been the first to foresee petroleum's "transcendental importance to the world's industrial future," and, following up vision with action, has been the most active in providing for that future.

BRITAIN'S METHOD OF CONTROLLING OIL SUPPLIES

Sidney Brooks's phrase, "commercial statesmanship," may be the transatlantic term for "dollar diplomacy," but it aptly describes the British method of seeking

TAMING A GUSHER

The big Mexican well, despite its great earth forces, was brought under control. A closer view of Cerro Azul No. 4 after the wrecked derrick was cleared away and heavy clamps, five feet long, fitted over the top of the well-casing (see successive steps in mastering the well, pages 196, 197, and 199).

THE HALTER HALF ON

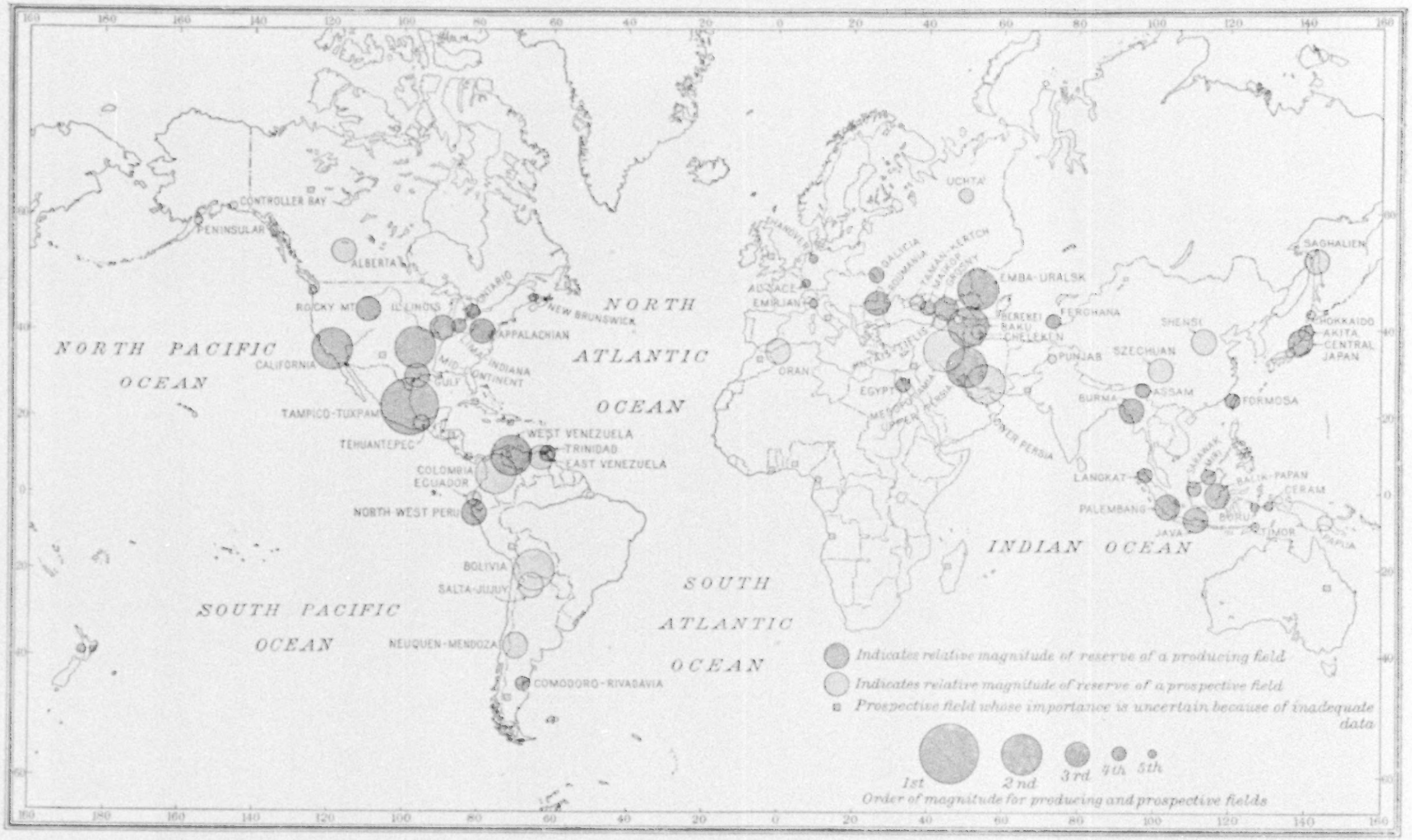
The heavy valve is partly on and is spraying part of the oil hundreds of feet on one side. Any one who has screwed a nozzle on a garden hose understands the process in miniature, but this oil-hose was running at the rate of three barrels a second (also see illustrations on pages 196, 197, and 199).

Photographs from Mexican Petroleum Co.

Photograph from Mexican Petroleum Co.

THE VICTORY WON: THE WORLD'S PREMIER OIL GUSHER HARNESSED

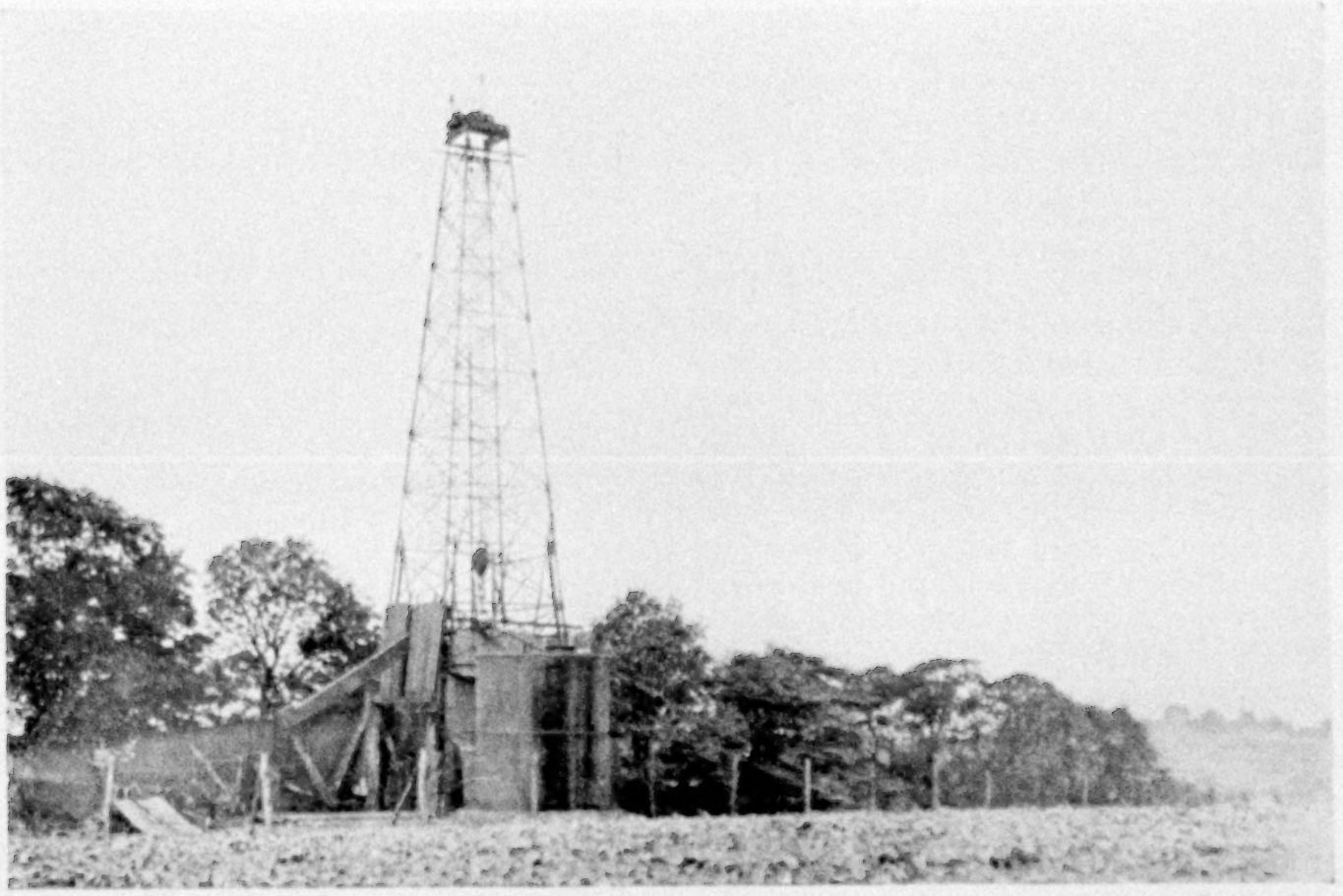
The successful issue of a week's campaign, for which there had been months of preparation. The valve is in position and ready to close. All of the flow now passes through the pipe, and the great reservoir of oil, 1,752 feet below the surface, is thus connected up with the 8-inch pipe lines running down to Tampico, where tankers load to supply the oil-hungry world (see other photographs of the Cerro Azul well on pages 196, 197, and 198, constituting a pictorial history of the great Mexican gusher).



From the U. S. Geological Survey

KNOWN AND POSSIELE OIL RESOURCES OF THE WORLD

A diagrammatic index showing distribution and relative size of oil supplies for the future, as estimated according to present information (see page 195).



Photograph from Arthur C. Veatch

ENGLAND'S DISCOVERY WELL

Located in Derbyshire by an American geologist, drilled by American engineers and skilled workmen, with American machinery and well supplies, this all-American well struck oil in England almost exactly 60 years after Drake discovered oil in Pennsylvania.

control of an oil supply adequate for the nation's needs. John D. Northrop, in a review of the political and commercial control of the petroleum resources of the world, thus sums up the British position:

"The strength of Great Britain's present position in the world's petroleum affairs lies in a strong governmental policy in the matter and in the wide scope of British petroleum investments, embracing practically every country of which petroleum is an important product and nearly every country of which it is a product of potential importance."

Not only do the British oil companies rejoice in such suggestive names as "British Controlled Oilfields," but at the stockholders' meetings the policy is stated in plain language as providing the safeguard of a voting trust so that no financial control "can divert even a single barrel of oil from national or imperial requirements."

It is easy to see that Great Britain's world-trade policy has given oil this "imperial" recognition; and when we picture the return of the American flag to the seven seas, we too must plan for an oil supply available wherever needed. Any nation which today aspires to a large part in world commerce imposes upon itself an oil problem, for the future freedom of both the sea and the air will be defined in terms of oil supply.

AMERICAN SHIPS AND THEIR APPETITE FOR OIL

The new demand of our shipping program alone involves fuel oil in quantities equivalent to nearly one-half of the present domestic output, and, unless there is some corresponding decrease in other demands, this new requirement must be met with an increase in production of crude oil of nearly 200 million barrels.

The United States shipping program further calls for a chain of oil stations encircling the globe. The Shipping Board has already announced that the first steps have been taken to establish fuel stations along the trade lanes as well as at the world's cross-roads, and thus to assure unrestricted operation of our ships in the world's trade.

But economy on a large scale will mean that not only must the oil supply be put where it is needed, but the oil must come, if possible, from near-by sources. American tankers encircling the world with cargoes of Texas or California oil appeal to the imagination, but involve too high a transportation cost; better, some control of oil supply on other continents.

America's experience on the world scale has been gained as an oil merchant more than as an oil-producer. The illumination of the Orient with American kerosene has been followed by the lubrication of the whole world with special oils from American refineries; and now we hear of a garage in Guatemala 7,000 feet above the sea, or another in far-off Australia using American gasoline and lubricants exclusively.

This commercial campaign has been a worthy one, especially in its far-seeing outlook; but do we look far enough? We have been draining our own oil pools in part to supply the needs of the rest of the world, but we have made little effort to render the rest of the world self-supporting in oil production. Whether such a national policy is to be characterized as that of a spendthrift or that of an altruist, it is certainly too short-sighted.

NEED FOR OIL PIONEERS

The facts of the present situation call for some new pioneering by the United States. This appeal to American brains and American dollars is made for the patriotic purpose of providing for the future well-being of our own country. Already American geologists have helped to develop the oil resources of every continent, the latest contribution being that of A. C. Veatch, who as chief geologist for Lord Cowdray located the discovery well at Hardstoft, Derbyshire, England. This pioneer well struck oil at a depth of 3,078 feet, and since June has been flowing at the rate of 12 barrels of high-grade oil a day.

Central England has thus been shown to be of importance as a source of petroleum; and it is gratifying to note that American geologists, American engineers and drillers, American rigs, and American oil-well supplies thus all "did their bit" for Great Britain at the time when the submarine menace led Lord Cowdray to place his petroleum staff at the disposal of the nation.

This pioneering spirit should now lead American capital and American engineering to seek new sources of petroleum supplies in foreign fields for the benefit of the America of tomorrow. Nor can this be done without popular support, inspired by general appreciation of oil as our servant, a servant that works 24 hours a day and 7 days a week.

The "open-door" policy is best for America and the world; encourage American capital to enter foreign fields and protect foreign capital wherever invested in our country. However, the spirit of reciprocity does not require that the United States shall always keep its own door of opportunity open to the nationals of all nations, irrespective of their attitude to Americans in the other parts of the world.

The part our Government should take in planning to meet our future needs is to give moral support to every effort of American business to expand its circle of activity in oil production, so that it will be coextensive with the new field of American shipping.

This may mean world-wide exploration, development, and producing companies, financed by United States capital, guided by American engineering, and safeguarded in policy because protected by the United States Government.

Thus only can our general welfare be promoted and the future supply of oil be assured for the United States.

INDEX FOR JULY-DECEMBER, 1919, VOLUME READY

Index for Volume XXXVI (July–December, 1919) will be mailed to members upon request

The trademark of supreme musical quality

which identifies the world's largest and greatest musical industry

Every important improvement that has transformed the talking machine from a triviality into an exquisite and eloquent instrument of the musical arts originated with the Victor. The Victor plant, the largest and oldest of its type in the world, is the world-center of great music.

No other organization in the world is so qualified by experience, by resources, and by artistic equipment to produce *supreme quality* as the Victor Company. Its products convey more great music by great artists to more people throughout the world than all other makes combined. If you wish the best, buy nothing which does not bear the famous Victor trademark: "His Master's Voice."

New Victor Records on sale at all dealers on the 1st of each month.

VICTROLA

Victor Talking Machine Co., Camden, N. J.

The Wonderful Story of the Tin Can

IF the tin can has been to you a common thing of commonplace service, think that way of it no longer. Think of the tin can for what it *really* is—a wonder of the times. Think of it as a monument to patient achievement in our personal interests.

What a tale it could tell! A tale to compel our respect and whet our appetites.

Once this tin can lay inert in the Earth in its original elements—had lain there since Time began—awaiting the hand of man that should bring it forth, make the metal, give it shape, and crown it with great usefulness.

And while it thus lay, awaiting its destiny, there likewise lay those other ingredients, from which Nature herself should bring forth the products of garden, orchard, and field, so wonderfully nourishing and delicious.

What a stimulus to imagination! What a tribute could be written to what Earth holds in trust for her people! How she holds in one hand the

© 1920—National Canners Association

secret of the peach, the pineapple, the succulent vegetable! How she holds in the other the no less wonderful secret of the means that shall carry her bounty to any table—anywhere—any time of the year.

Today, all these ingredients lie dormant together. Tomorrow, rising from the earth, they meet again, each to triumph in "the miracle on your table."

But Nature's triumph means man's triumph, also. The tin can of commerce was not born in a day nor without great industrial travail.

The can-making industry in America parallels that of food-canning itself. In the beginning, each canner made his own cans, and a workman in those days could make by hand 150 per day.

Today, production of more than Six Billion cans annually for the canned food output of America is significant of the development of the tin can industry, and of the canned food industry, as well, which makes all these millions upon millions of cans necessary. The imagination is staggered by it. Expressed in terms of tables supplied and of individuals served, it is almost beyond belief.

The "tin" can is a steel can, coated with tin. It is a product of science, of scientific research by hundreds of specialists who have studied every step of evolution beginning with analysis of the steel itself.

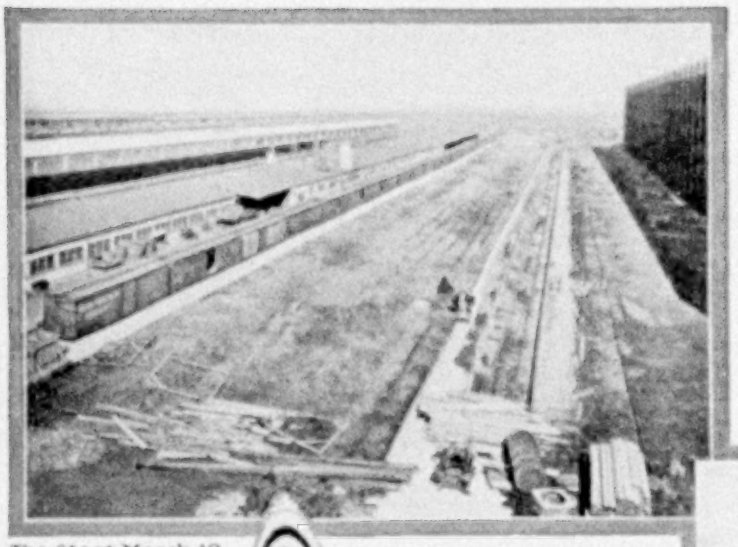
For example, over a period of years, picked men from the laboratories of four great organizations united in the common effort of developing the tin container. These were the laboratories of steel manufacturers, tin-plate manufacturers, can manufacturers, and the National Canners Association. Special "heats" of steel were experimented with, foods packed in the cans produced from the steel, and the results recorded with scientific accuracy. The thickness of the tin coating became a matter of scientific determination. Methods of sealing and imperviousness of joints are subjects of closest scientific scrutiny.

As the tin can stands on your grocer's shelves or on the shelves of your own pantry, this highly specialized little object claims your respect. The tin can unquestionably is the safest, most practicable and scientific food container that human skill and ingenuity have been able to devise for the benefit of mankind.

NATIONAL CANNERS ASSOCIATION
WASHINGTON, D. C.

A nation-wide organization formed in 1907, consisting of producers of all varieties of hermetically sealed canned foods which have been sterilized by heat. It neither produces, buys, nor sells. Its purpose is to assure, for the mutual benefit of the industry and the public, the best canned foods that scientific knowledge and human skill can produce.

Speeding Construction to Increase Production



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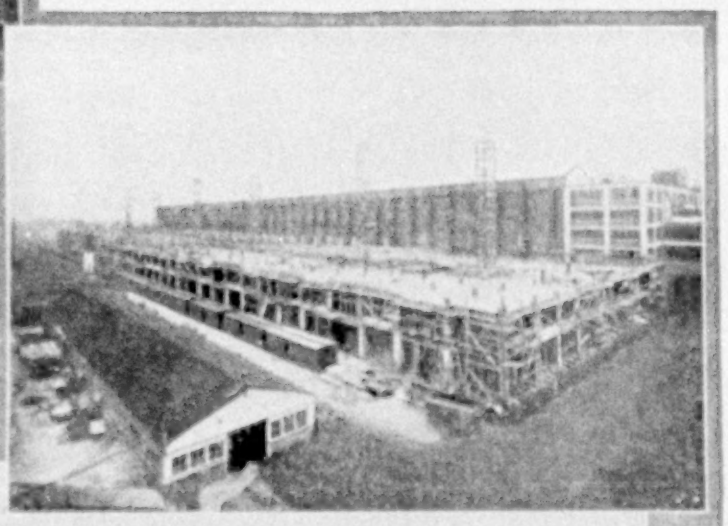

2 Months Later

4 Months Later

GEORGE A.
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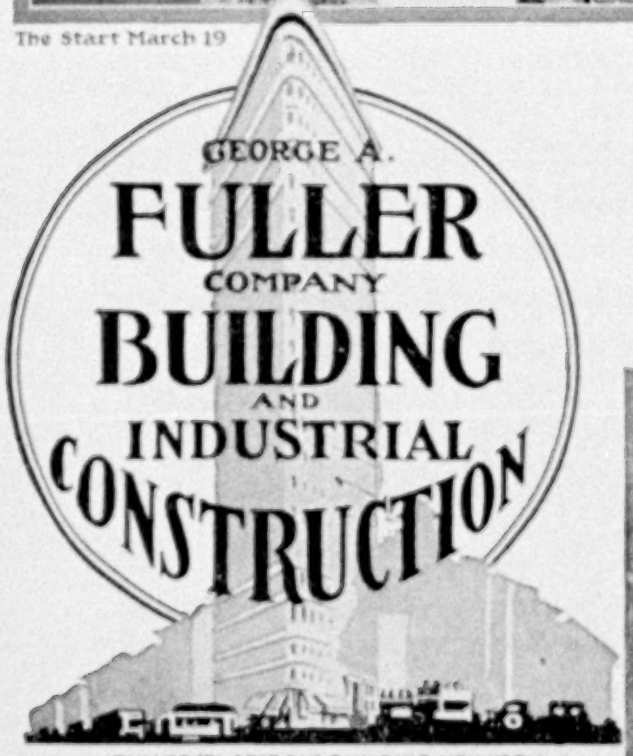
CONSTRUCTION



FULLER (FLATIRON) BUILDING, NEW YORK

Finished and Accepted August 1

A Fuller-Built Landmark For Ford Motor Company

WHEN the Ford Motor Company needed increased facilities and needed them quickly they turned to Fuller. The result was a six-story built-to-order factory 842 feet long and 164 feet wide in 117 working days.

Six other contracts from the Ford Company followed the completion of this building.

Experienced men from any of our offices will be glad to consult with architects and owners on any contemplated building work.

George A. Fuller Company

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New Orleans	Washington	Baltimore	Pittsburgh
Cleveland	Chicago	Detroit	St. Louis
Kansas City			Buffalo

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Brunswick

RECORDS

AND finally Brunswick Records—artistic companions of Brunswick Phonographs. These records are made under the direction of great interpreters—men who have the power and faculty of developing musical selections as they would be played by the composers.

Just as there are directors for the opera, the stage, the orchestra, we now have directors for records.

This means that each Brunswick Record is not only the work of some accomplished artist, but is accompanied by the shadings of a renowned director.

This is why Brunswick Records rise above the qualities most records have in common. Brunswicks are more than title and artist. They bear the impress of some guiding hand. One who knows how to bring out the inherent qualities, the hidden beauty, the magnetic personality, the more spiritual intuitions of the composers.

Ask to hear these records. Made by the House of Brunswick—a name renowned in the world of music. Compare Brunswick Records with others. Be their sole judge! Look for something entirely different. Something sweeter, richer, truer! You'll find it in full measure in this new Brunswick disc!

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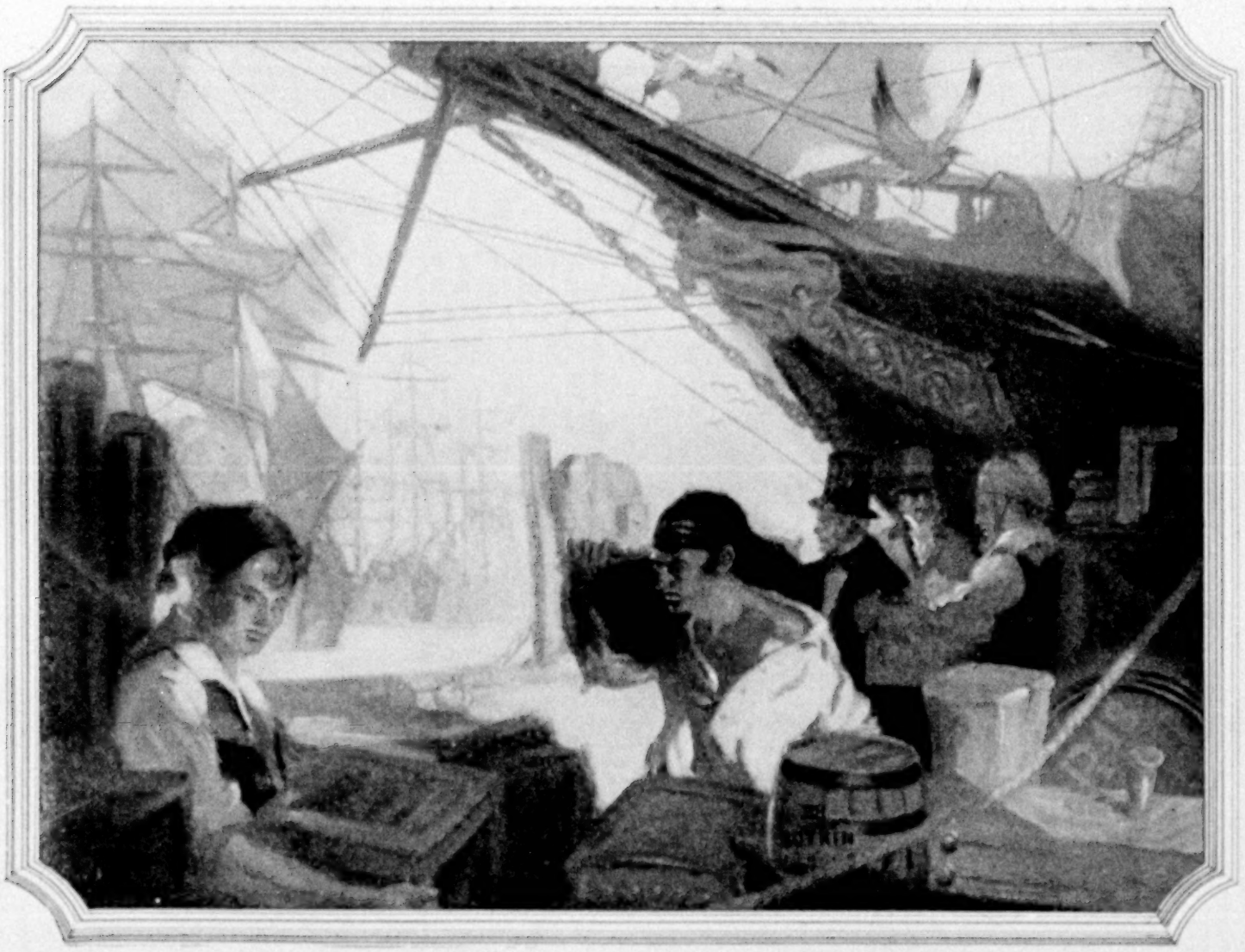


Salem in 1800—the beginnings of the American Merchant Marine

NEW ENGLAND comes naturally by her maritime prestige and mastery. Her ports on the Atlantic are very fortunately situated. As compared with others, they are hundreds of miles nearer Europe. Their harbors could comfortably shelter the world's fleets, and their wharves are favored by direct rail communication to all inland centres. In all respects they are the natural gateways for foreign trade.

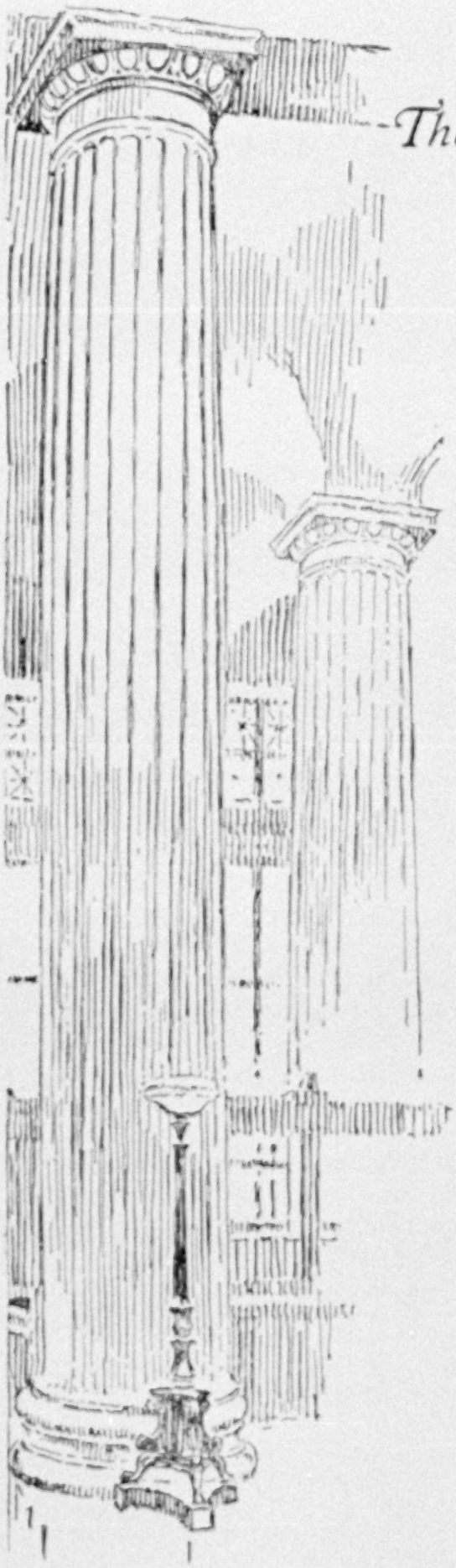
In Boston, New England possesses a port of entry and export yielding only to New York and Philadelphia in rank. During the year 1918 the imports at the Port of Boston amounted to $295,915,214, and the exports during the same period $221,314,900.

Directorates of industries throughout the country desiring to benefit by the advantages of New England seaports will find the Old Colony Trust Company equipped with exceptional facilities for remitting funds by cable, issuing commercial credits, financing exports and imports, furnishing foreign credit data, and locating markets for goods throughout the world. Send for our booklet—"Your Financial Requirements and How We Can Meet Them."

Come to New England this Summer—the Tercentenary of the Pilgrims' Landing, and make this Company's office your banking headquarters.

OLD COLONY TRUST COMPANY
BOSTON

"Mention The Geographic—It identifies you"



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Resources over Five Hundred Millions

Teeth Grow Dingy

Because You Leave a Film

All Statements Approved by High Dental Authorities

Teeth Are Ruined by It

This is why the daily brushing so often fails to save the teeth.

The cause of most tooth troubles is a slimy film. You can feel it with your tongue. It clings to teeth, enters crevices and stays. Ordinary brushing methods do not end it. So, month after month, the film remains and may do a ceaseless damage.

That film is what discolors—not the teeth. It is the basis of tartar. It holds food substance which ferments and forms acid. It holds the acid in contact with the teeth to cause decay.

Millions of germs breed in it. They, with tartar, are the chief cause of pyorrhea—a common and serious trouble.

Now a Way to Combat It

These facts have been known for years, but dental science found no way to effectively combat film. Now that way is found. Able authorities have proved it by careful tests. Leading dentists all over America are urging its adoption. And millions of teeth are now cleaned daily as they never were before.

The method is embodied in a dentifrice called Pepsodent. And, to spread the facts, a 10-Day Tube is being sent to every one who asks.

Based on Active Pepsin

Pepsodent is based on pepsin, the digestant of albumin. The film is albuminous matter. The object of Pepsodent is to dissolve it, then to constantly combat it.

The way seems simple, but for long it seemed impossible. Pepsin must be activated, and the usual agent is an acid harmful to the teeth. Now science has discovered a harmless activating method. And now active pepsin is embodied in an ideal tooth paste, modern in every way.

The results are quick and apparent. One sees at once that Pepsodent means whiter, safer teeth. Make this ten-day test in your own home, in justice to yourself.

See What Ten Days Will Do

Send the coupon for a 10-Day Tube. Then note how clean the teeth feel after using. Mark the absence of the slimy film. See how teeth whiten as the fixed film disappears Compare your teeth in ten days with your teeth today. Then decide for yourself what is best. Cut out the coupon now.

Pepsodent
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A scientific film combatant now advised for daily use by leading dentists everywhere

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Ten-Day Tube Free

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Send 10c. in stamps for booklet, "Practical Hints for Amateur Weather Forecasters."

Taylor Instrument Companies

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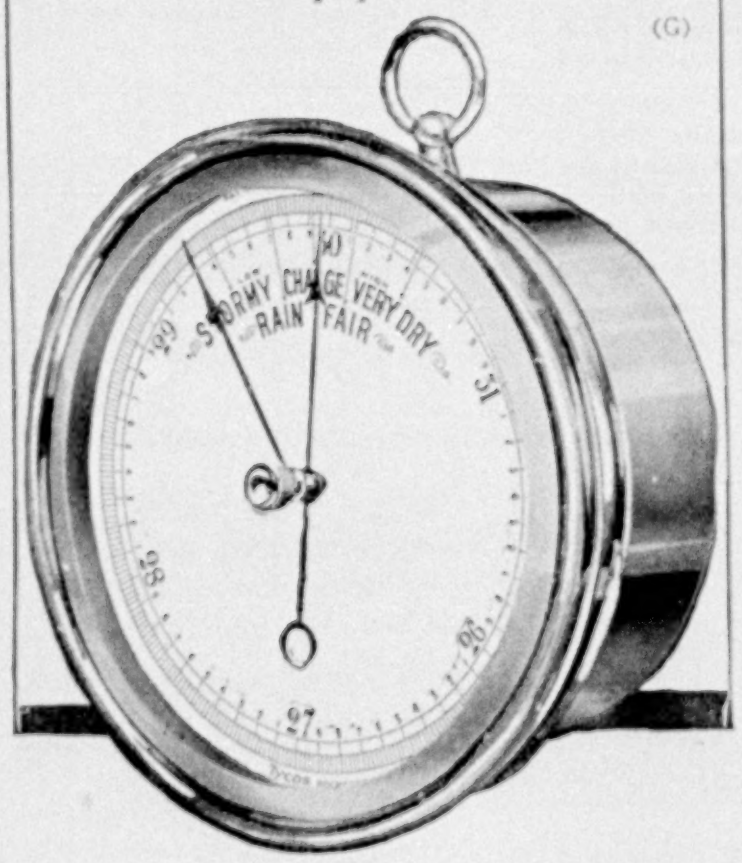

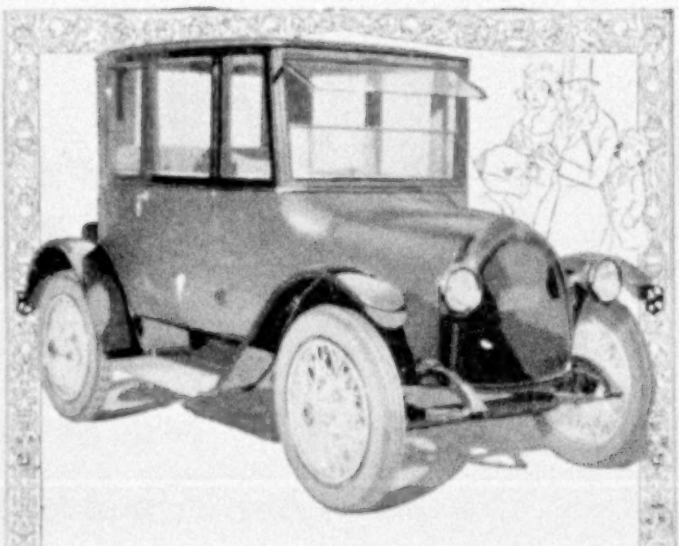

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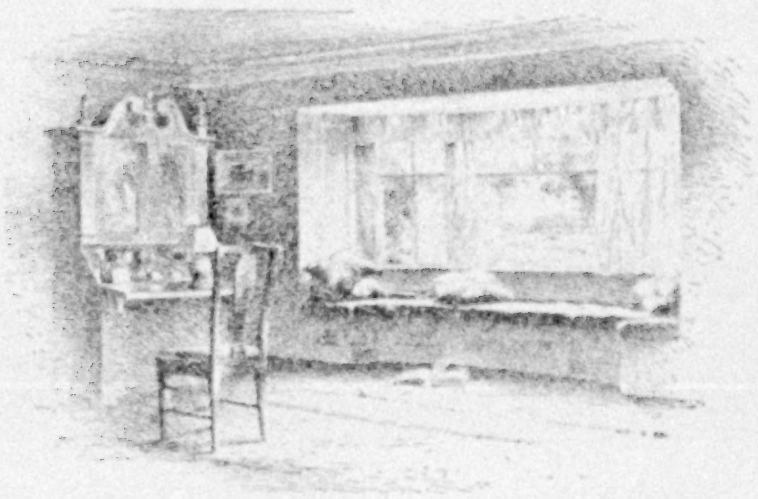

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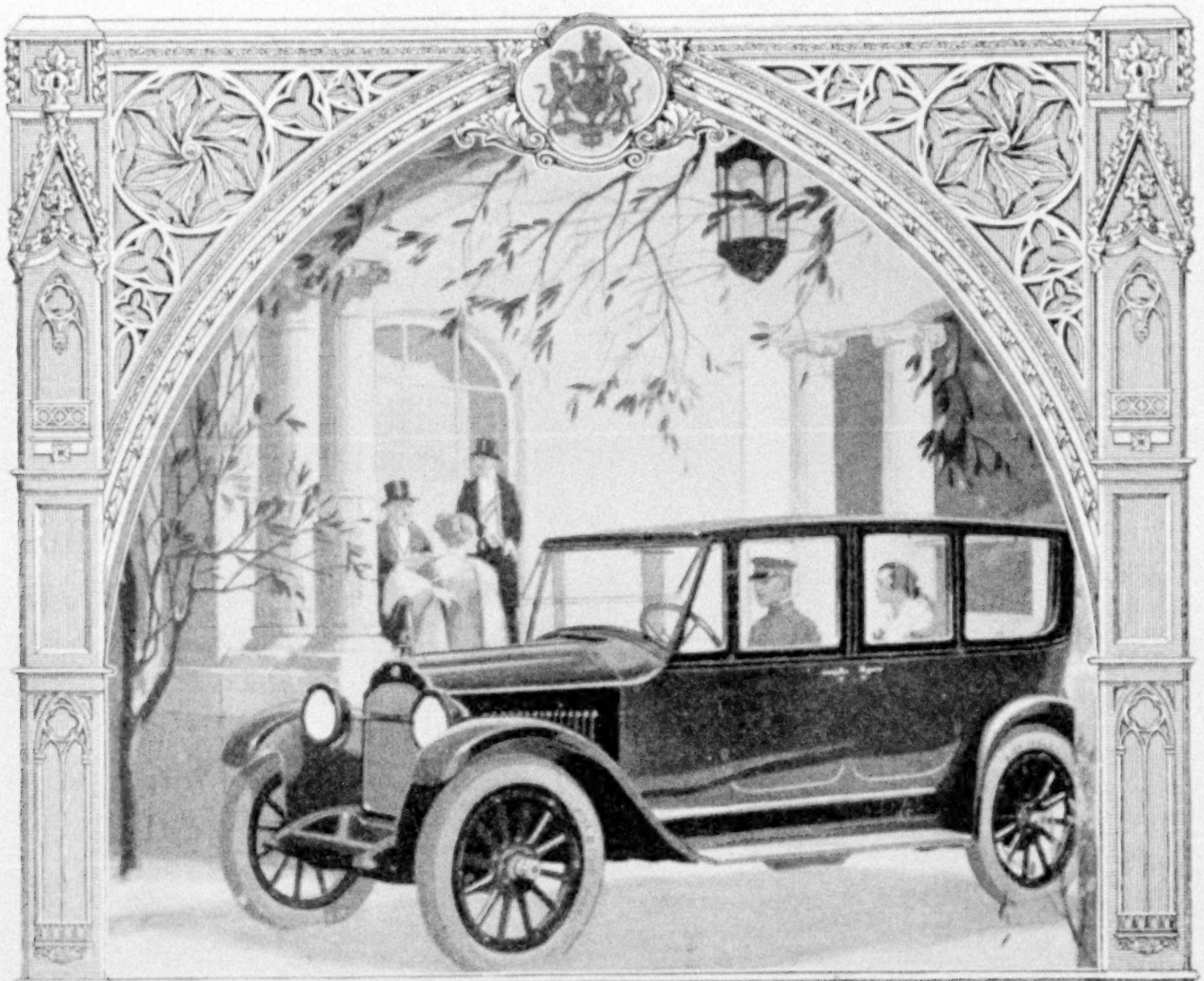

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THE owner of a Willys-Knight always knows what to expect from his sleeve-valve motor. Instead of deteriorating it *improves with use*. Its *only* change is a change for the *better*.

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Willys Knight
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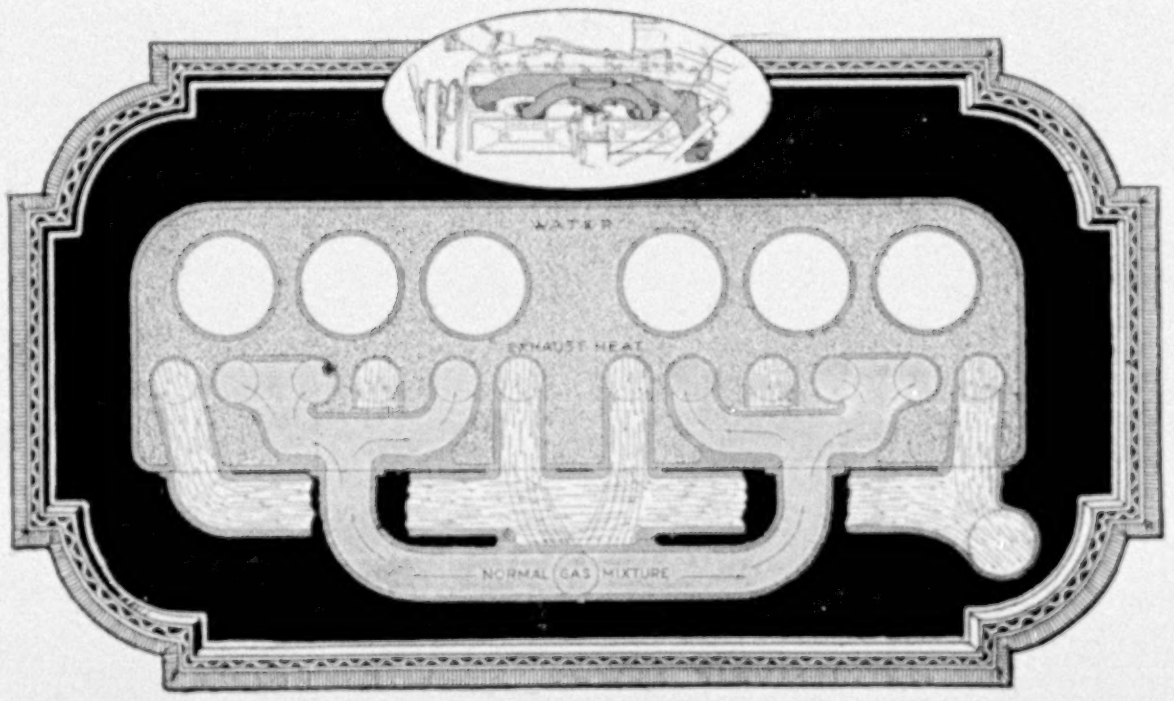
IMPROVES WITH USE



Why the Hot Spot Chalmers is Two Years Ahead of the Times

A GREAT many motor cars today are not behaving the way they once did. The trouble is not with the car, but with the gas you feed it. For gas has gone down and down in grade and there has been only one engine designed which meets successfully this condition. That engine is found in a Hot Spot Chalmers.

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But Hot Spot merely starts the work. It remains for Ram's-horn to complete it. Ram's-horn, as its name implies, is shaped like the horn of a ram. This means that when the gas leaves Hot Spot each cylinder is just exactly the same distance away. Therefore it is quite impossible for one cylinder to get more gas than another, or better gas.

Ram's-horn not only feeds the "pulverized" gas to the cylinders in the most direct route known to a gas engine but also the quickest route.

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The name "Kodak" does not mean that these goods must be used in connection with a Kodak camera, for as a matter of fact any of them may be used with other apparatus or goods. It simply means that they originated with, and are manufactured by, the Eastman Kodak Company.

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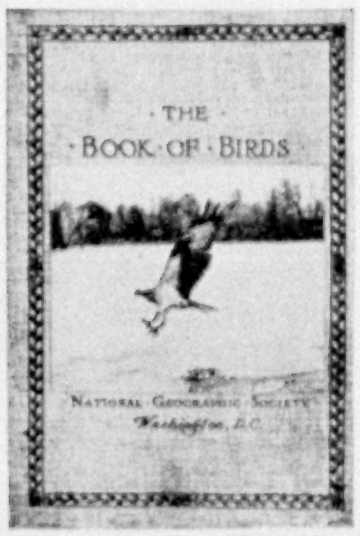

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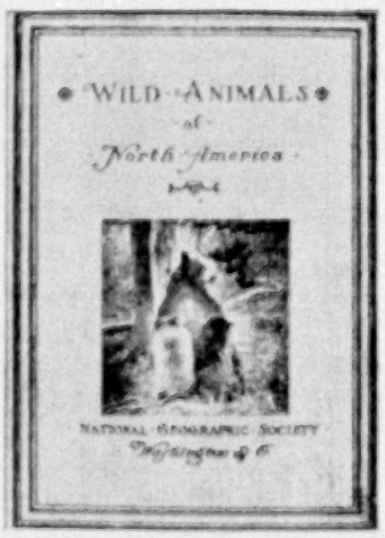

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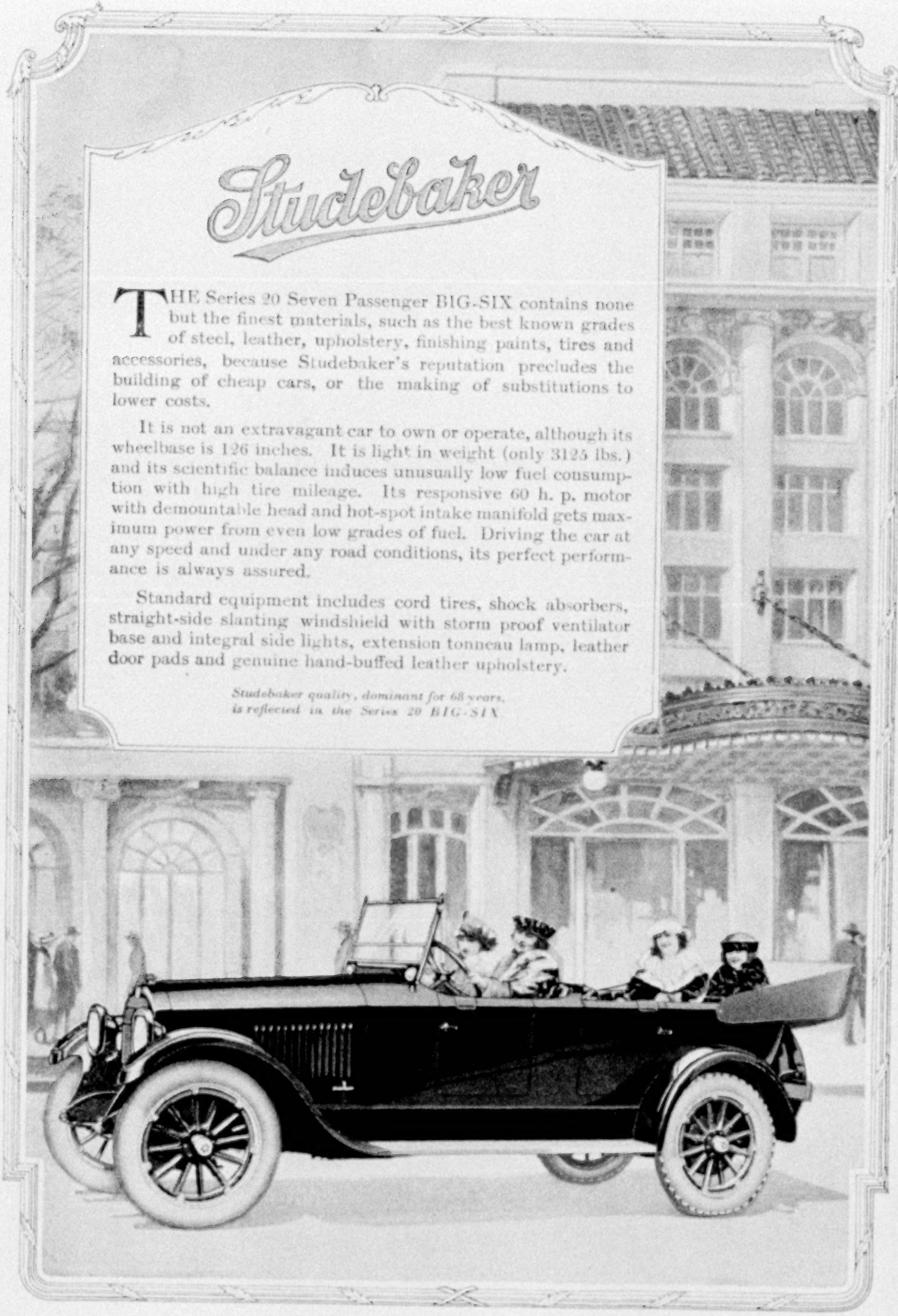

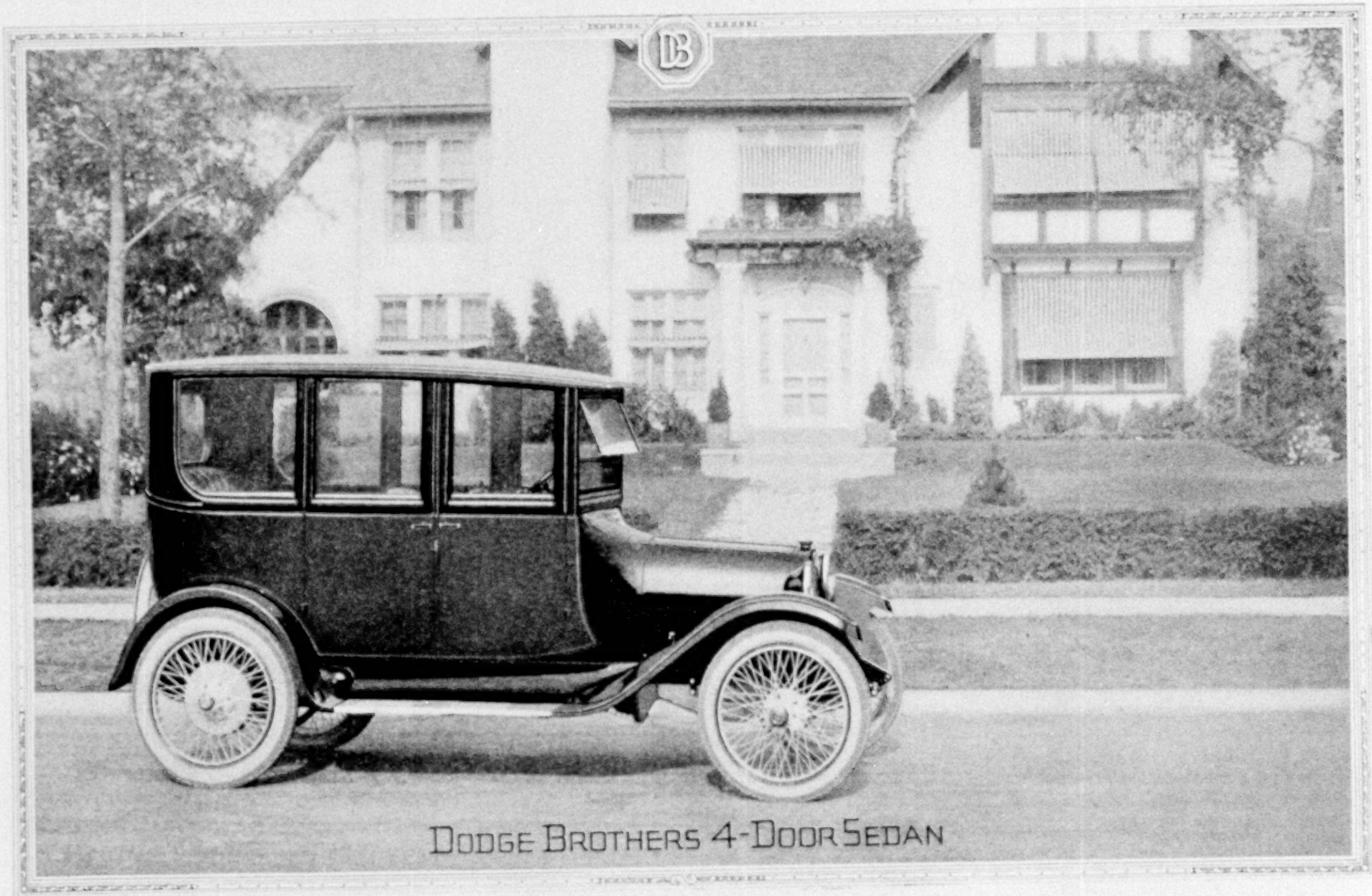

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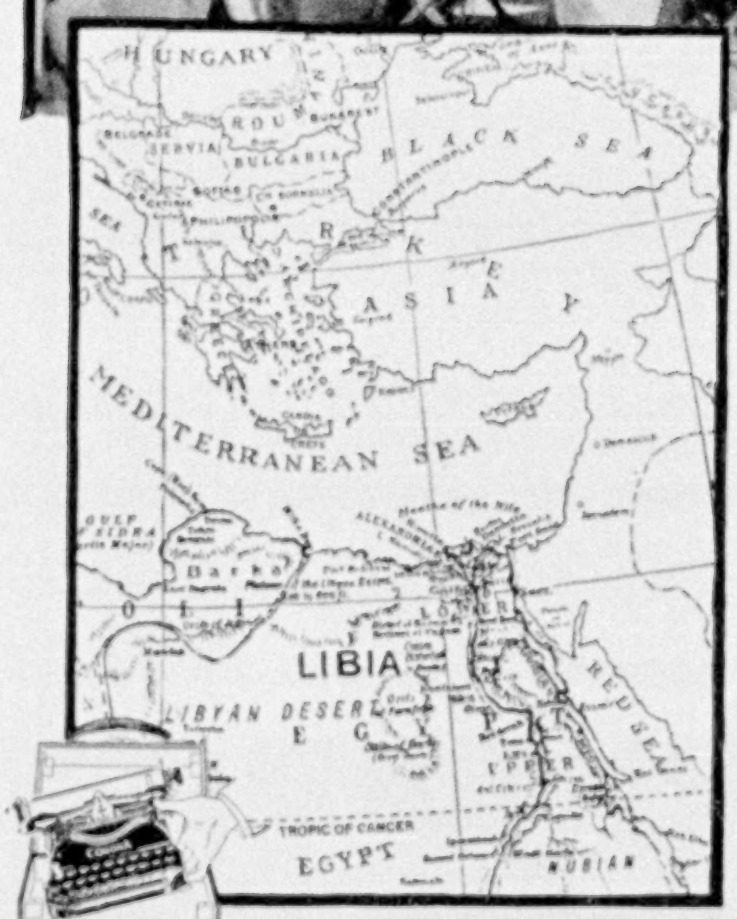

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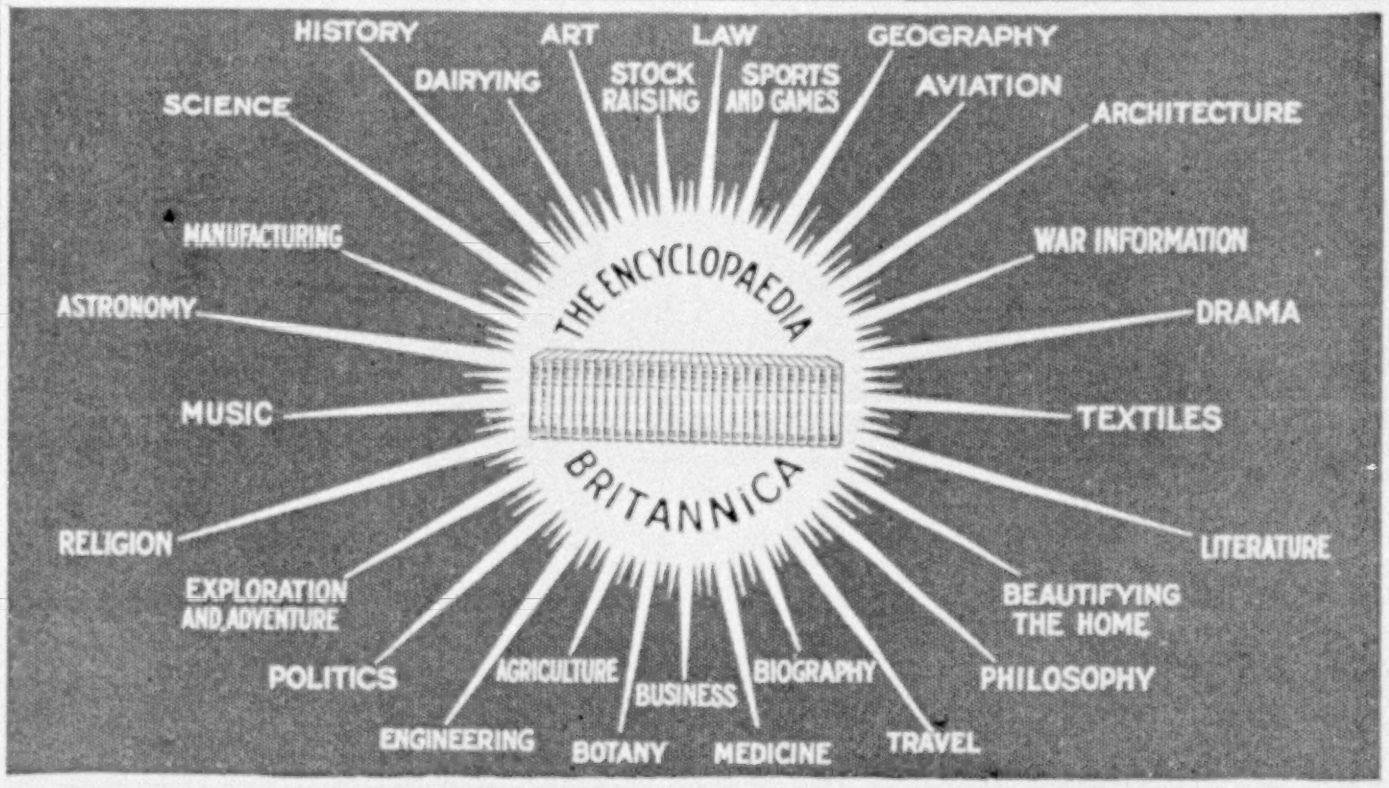

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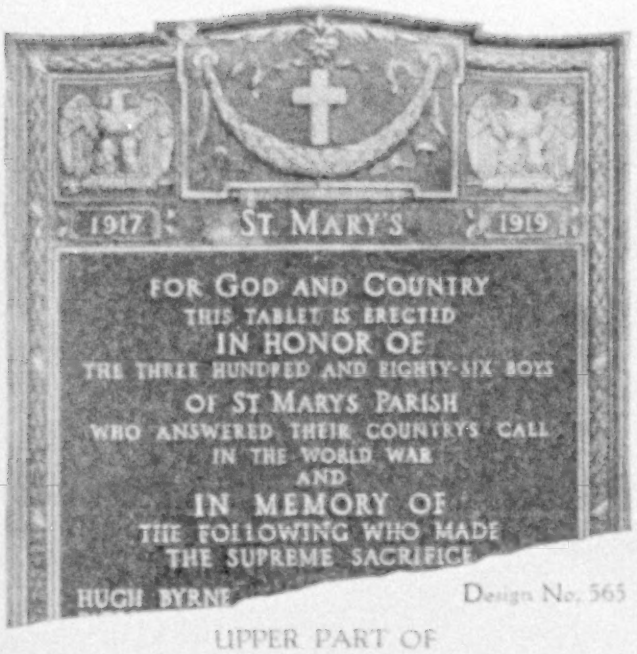

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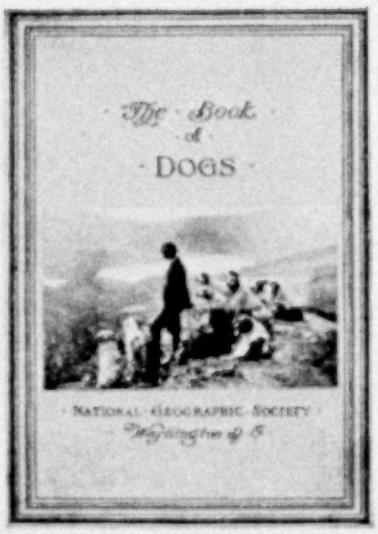

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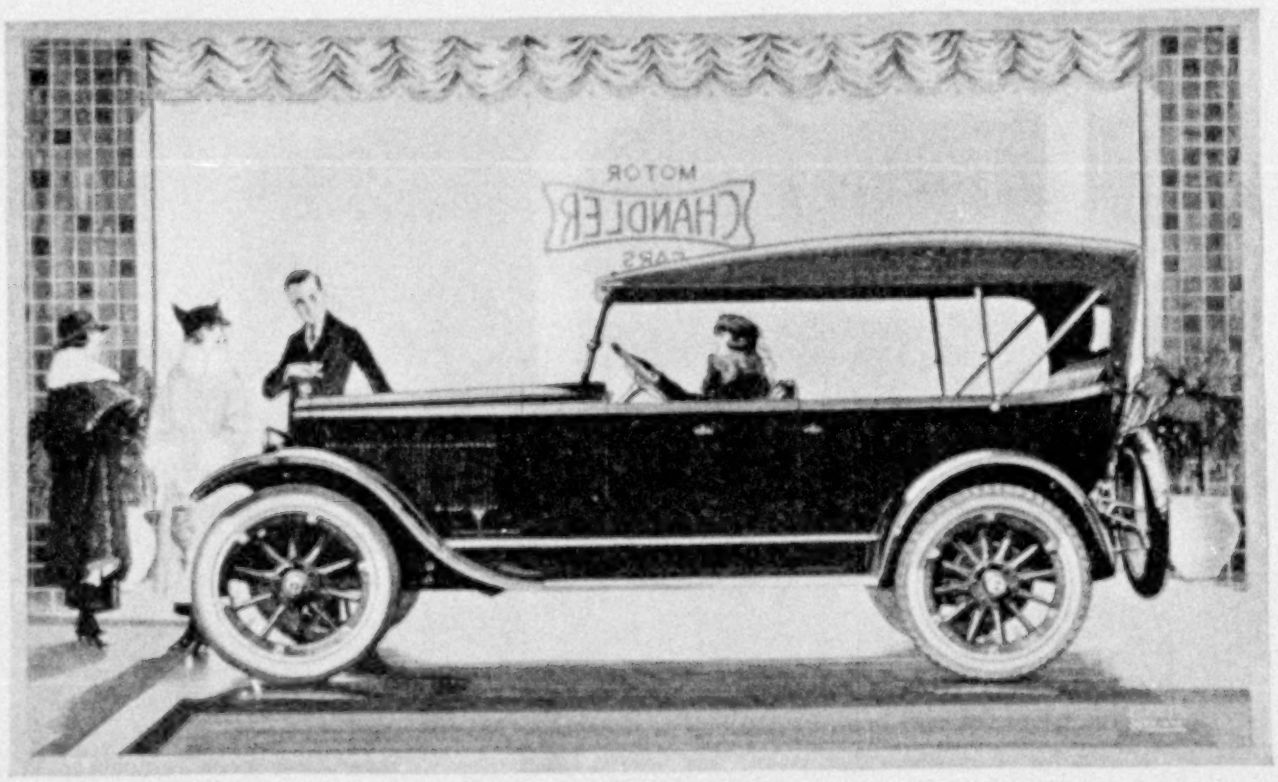

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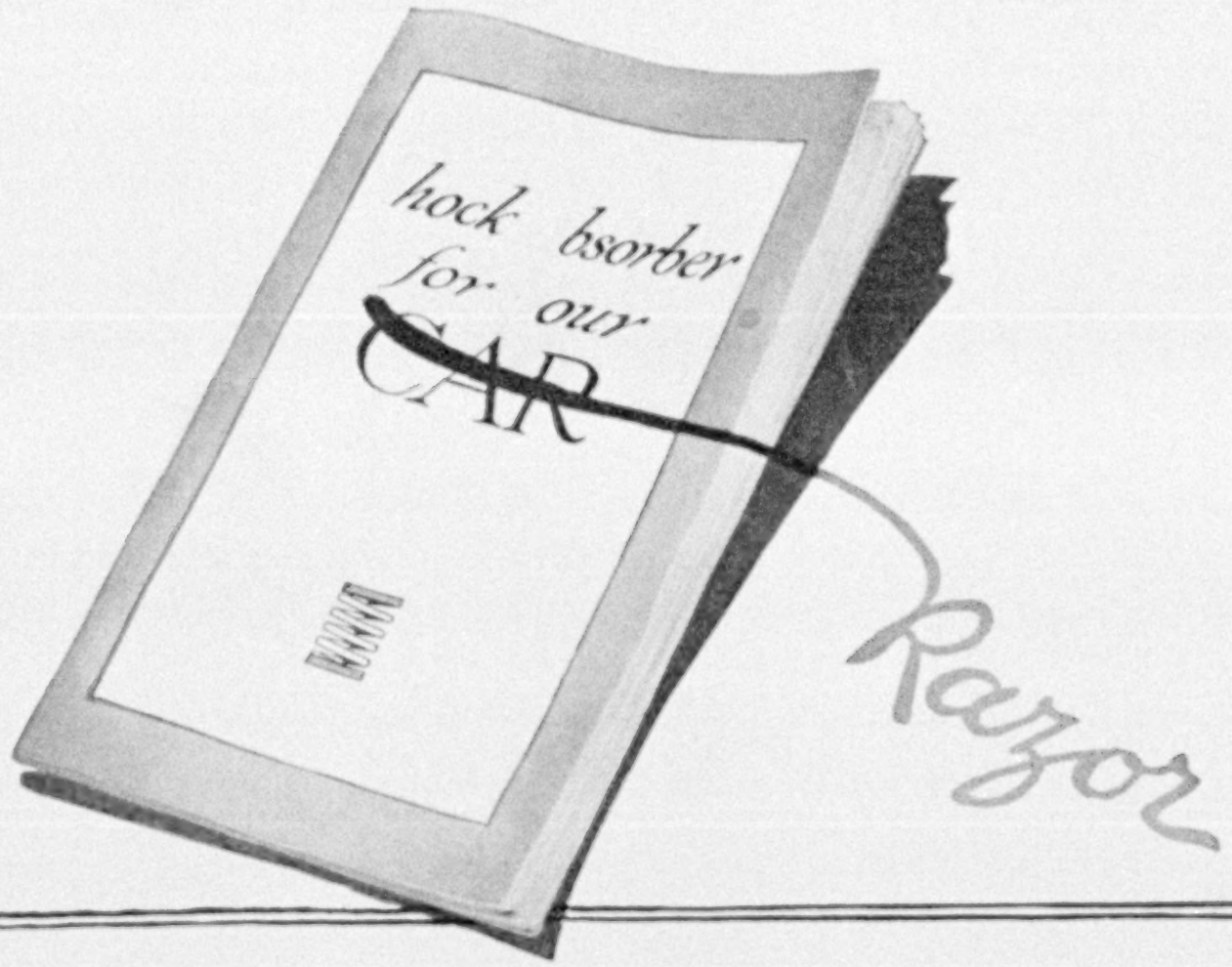

Hints for Applying

There is no need to rub Colgate's lather in with the fingers. Don't do it—it only adds "mussiness" to what might be a genuine pleasure. Shave this way—and learn comfort.

With the Stick: After wetting the face, pass the stick over the cheeks from ear to ear and back again; then under the chin; once across the upper lip. This gives soap enough for any but the heaviest beard. Work up the softening lather on the face with the wet brush, using hot or cold water.

With the Powder: First wet the face with the brush. Separate the bristles slightly with the thumb and sprinkle about one-third of a thimbleful of powder on the brush—you soon learn the exact amount you need. The lather is quickly worked up with hot or cold water—on the face.

With the Cream: If you prefer to apply the cream to the face, always wet the face first. If you squeeze the cream on the wet brush, wet the face first. The plentiful, fragrant lather is then worked up on the face with the brush—using hot or cold water, according to preference.

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